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TEACHING THE PERIODIC CLASSIFICATION OF ELEMENTS.

BY ROYCE H. LEROY,

Professor of Chemistry, Doane College, Crete, Neb.

Since the time of Mendeleef and Meyer various attempts have been made to improve the original classification of the elements. Every resulting change or modification has embodied the original ideas and the periodic classification as presented by Mendeleef has suffered change in form and not in principle. Probably the modifications best known at the present time are the helical form of Soddy, the spiral form due to Harkins and the Deming modification of Werner's table, this last being better known as the "eighteen column" form. Lately the Dushman table has received much favorable comment. Each of these has its own particular advantages over one another and over the original Mendeleef form. Recently there was published in the Journal of Chemical Education, III, 9, 1058, (1926), an article by Monroe and Turner in which they describe another and new type of table, and it is of this last type of table that this article treats.

Everyone who has taught beginning chemistry and has attempted to teach the periodic classification of the elements knows that the old Mendeleef type of table is a bug-bear as far as the student is concerned. If any twenty of the most common textbooks in use for teaching beginning college chemistry are examined, it will be found that with but very few exceptions the treatment accorded the periodic system is most meager. The eighteen column form as developed in Prof. Deming's "General Chemistry" well merits the full and complete treatment that he gives. That table is a very marked improvement over the original Mendeleef type as far as presentation to beginning classes is concerned. The presentation of the Harkins

or the Soddy table to a class of beginners in chemistry would be ridiculous to even think about.

The table presented herein very closely resembles the form shown by Monroe and Turner. It is a modification of the eighteen column form and the principal change is a shift of groups OA, IA, II A and III A, in the order named, to the right of group VII A and the name of OA changed to Transition A. Minor changes follow.

There has been apparently no reason at all for calling the group of inert gases the O group, except the fact that the elements of that group are inert and have never been caused to exhibit valence. By changing the names of both OA and VIII B to "transition," the naming and numbering of both the A and B groups is made uniform and it is shown below that these groups can truly be considered transition groups in their relation to groups VII and I.

The greatest diversity of properties is shown in the move from group VII A to I A and this diversity is fittingly set off and accentuated by the transition group of inert gases, placed between those two groups. The same is true in the B groups, the transition group occurring between the acid characteristics of VII B and the basic characteristics of I B. This at once shows to the beginner that a very apparent change in the structure of the atom has occurred (and hence in the chemical properties of the elements) as we pass from chlorine to potassium, or from bromine to rubidium, and so on. Furthermore, the placing of this group in the position shown in this modification gives a practical use to the group of inert gases, whereas up to this time it has been placed at either one end or the other largely because there was no other place to put it and no reason for placing it elsewhere.

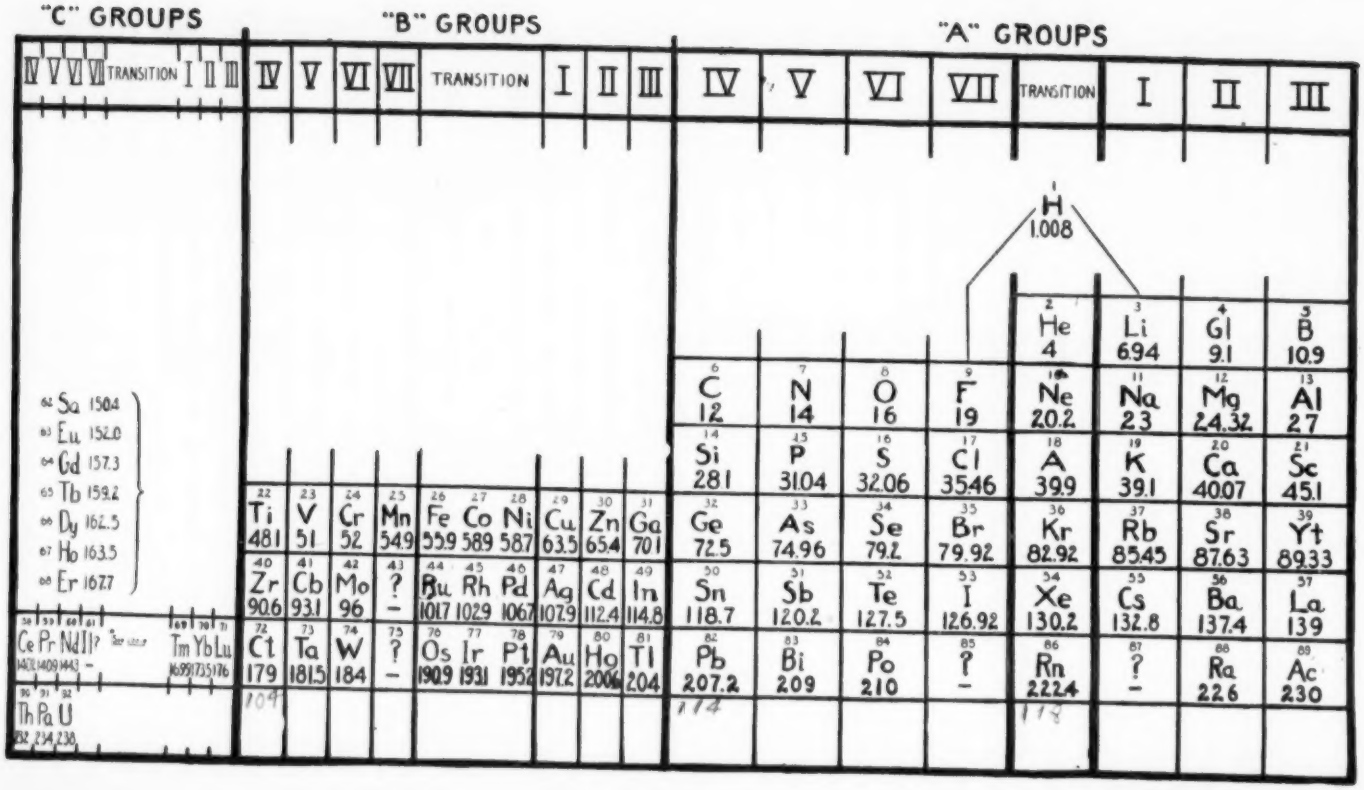
This probably is the first table (except that of Monroe and Turner) constructed on a plane surface where the A and B groups are separated from each other and yet are kept intact individually. In both the Werner table and Deming's modification, the A groups are separated by intervening B groups. If a table of the elements is to show in the simplest fashion possible the relation of the elements to each other, and the relation of certain groups of related elements to other groups of related elements, then the members of the A groups should in no wise be separated from each other as is done in both of the two forms just mentioned. Furthermore, this separation has been ef-

fected in this table without disturbing any of the relations of the Periodic table that already have been established.

Each numbered group occupies the same relative position, whether it is A or B. This point is of obvious value in the teaching of chemistry because the student soon comes to correlate the position of an element with its properties and vice versa. Again, this arrangement eliminates the necessity of the relationship lines of the 18 column form, making simplicity the keynote.

The difference in the horizontal spacing of the "A" and "B" groups aids the student to visualize the fact that the similarity of properties of the elements in the B groups is much greater than in the A groups, and emphasizes the "horizontal" relations of the B groups as contrasted to the "vertical" relations of the A groups. Manganese, in addition to possessing properties that are characteristic of the halogens, also possesses properties that are similar to copper. The predominant valence of the B groups is three, nearly all the elements in these groups form complex salts and nearly all their compounds are colored. There are no such common relations in the A groups. The use of a pictorial method, horizontal spacing, is the simplest method to bring to the student the idea that the succeeding elements of a period in the B groups are quite closely related and usually have properties in common.

The separation of the A groups from the B groups suggests a method of classification for the rare earth elements. Lanthanum has been shown by spectroscopic methods to be a bonafide member of group III A. Likewise, celtium (hafnium) has been shown to be very closely related to zirconium of group IV B. The change of properties from scandium to titanium and from yttrium to zirconium is comparable in every fashion to the change from lanthanum to celtium. Now the difficulty of accounting for the ten elements between scandium and titanium, and so on, was surmounted by calling them the B groups, and relationship to the corresponding A groups was established. It should be just as plausible then, to allow the fourteen rare earth elements occurring between lanthanum and celtium to be called the C groups, and arrange them accordingly. The accompanying plate shows such an arrangement following the atomic number order as in the A and B groups. Attention is immediately attracted to the transition group of seven elements. This is entirely analgous to the transition group of A and B groups. Only one element occupies the transition A group, and three in


"C" GROUPS
"B" GROUPS
"A" GROUPS
IV V VI VII TRANSITION I II III
IV V VI VII TRANSITION I II III
IV V VI VII TRANSITION I II III
62 Sa 150.4
63 Eu 152.0
64 Gd 157.3
65 Tb 159.2
66 Dy 162.5
67 Ho 163.5
68 Er 167.7
Ce Pr Nd ?
140.2 140.9 144.3
Tm Yb Lu
169.9 173.5 176
90 91 92
Th Pa U
232 234 238
1 H 1.008
2 He 4
3 Li 6.94
4 Gl 9.1
5 B 10.9
6 C 12
7 N 14
8 O 16
9 F 19
10 Ne 20.2
11 Na 23
12 Mg 24.32
13 Al 27
14 Si 28.1
15 P 31.04
16 S 32.06
17 Cl 35.46
18 A 39.9
19 K 39.1
20 Ca 40.07
21 Sc 45.1
22 Ti 48.1
23 V 51
24 Cr 52
25 Mn 54.9
26 Fe 55.9
27 Co 58.9
28 Ni 58.7
29 Cu 63.5
30 Zn 65.4
31 Ga 70.1
32 Ge 72.5
33 As 74.96
34 Se 79.2
35 Br 79.92
36 Kr 82.92
37 Rb 85.45
38 Sr 87.63
39 Yt 89.33
40 Zr 90.6
41 Cb 93.1
42 Mo 96
43 ? –
44 Ru 101.7
45 Rh 102.9
46 Pd 106.7
47 Ag 107.9
48 Cd 112.4
49 In 114.8
50 Sn 118.7
51 Sb 120.2
52 Te 127.5
53 I 126.92
54 Xe 130.2
55 Cs 132.8
56 Ba 137.4
57 La 139
72 Ct 179
73 Ta 181.5
74 W 184
75 ? –
76 Os 190.9
77 Ir 193.1
78 Pt 195.2
79 Au 197.2
80 Hg 200.6
81 Tl 204
82 Pb 207.2
83 Bi 209
84 Po 210
85 ? –
86 Rn 222.4
87 ? –
88 Ra 226
89 Ac 230
104
114
118

transition B. Allowing the first four elements of the rare earths for groups IV, V, VI and VII C, and the last three elements preceding celtium, for the groups I, II and III C, just as is done in the B groups, there are seven elements left, between the VII C and I C groups to occupy the transition group. The numerical relation of the increase of the number of elements in the transition group as we pass from A to B to C is simply expressed by

$$2n+1=m$$

where "n" is the number of elements in the preceding transition group. Thus for the transition B group, n = 1, the number of elements occupying transition A for a single period, and m, the number of elements for the transition group of the B series, is thus 3. Then for the transition C group n = 3, the number of elements in transition B, and the relation becomes

$$(2X3)+1=7$$

the number of elements occurring in the transition C group.

If the valence relation of the A and B groups is borne out in the C groups, then cerium, praseodymium, neodymium, and illinium may be expected to exhibit, at least in a small measure, valences of 4, 5, 6 and 7, in the order given. Likewise, thulium, ytterbium and lutecium should show valences of 1, 2 and 3. In this connection there is one relation that should be kept in mind,—the majority of the elements of the B groups exhibit a valence of 3. Among the rare earths every one of the elements is known to exhibit a valence of 3. The tendency of the C group elements to become more closely related to each other than the elements of the B groups is entirely analgous to the relationship of the properties of the elements of the B groups as compared to the A groups. In fact, the elements of the C groups are so closely related to each other that they are very nearly chemical identities and delicate and protracted fractionation methods are necessary to separate them. Cerium does show a valence of 4 and as would be expected, the tetravalent form is less basic than the trivalent. Praseodymium is known to form an oxide whose formula is PrO_2 and still another of the composition Pr_2O_5, thus indicating that it may have valences of 3, 4 and 5. Apparently no one has ever discovered a compound other than Pr_2O_5 in which praseodynium is pentavalent. There seems to be no truly confirmatory existence of neodymium in any form other than trivalent and far too little is known now of the newly discovered illinium to speculate as to the possibility of its being able to exist in a heptavalent form.

In the transition C group, Samarium forms the salts SmI_2 and $SmCl_2$ in addition to its series of trivalent compounds. There is no direct evidence of the other six elements, which occupy this space, existing in any other than the trivalent form.

Passing on to thulium, we might expect to find the monovalent form the most basic of the entire list of rare earth elements. Thulium is exceedingly difficult to separate because of its being in the soluble end of the fractionating series and little is known of its compounds as compared to some of the other rare earth elements. At least no compound of thulium has been isolated in which it is other than trivalent. This last is also true of ytterbium.

Summarizing, it can be said that since cerium and praseodymium are known definitely to conform to this type of classification, it may be that in the near future hexavalent and heptavalent compounds of neodymium and illinium (?) will be isolated and proved to exist. The fact that the members of the transition group with the exception of samarium are known at this time to have only a valence of 3 tends more to strengthen the reasoning for this method of treatment than to weaken it, for the prevailing valence of the elements of transition B is 3. It is hoped that more will be known of thulium and ytterbium and that research will be directed to discover compounds of all these elements in which their valence is other than 3.

The table as used at present is painted on heavy white oilcloth in five colors—the framework and group lettering is black, the atomic numbers are bright green, the symbols are bright blue, the atomic weights are red and the line setting off the more distinctly non-metallic type of elements is yellow. This scheme of using different colors has been found of great attraction to the students when they are working with the table, or reference is made to it. The whole table is seven and one-half feet long by four feet wide (Plate I).

This table was designed and discussed before a seminary of Inorganic chemistry at the University of Nebraska in March, 1926. The purpose of its construction was three-fold: (1) To provide a classification or table in which the "A" groups would be together yet keeping the "B" groups and "A" groups separate from each other; (2) To provide if possible a place for the rare earth elements and (3) To produce a table that would be more easily understood by a beginning class in chemistry.

The table as presented here differs from the table of Monroe

and Turner in the four respects: (1) The Monroe and Turner table places boron and aluminum in group III B rather than III A. (2) The position accorded the rare earths is pictured differently on the plane diagrams, but actually are identical; Monroe and Turner discuss the possibility of a third set of groups as exemplified in the rare earths, and their helical form shows this but their plane diagram merely suggests it, with all detail left to the reader's imagination. Moreover, as the plane table of Monroe and Turner is a plane representation of their helical form so this table may be considered as derived partially at least from Harkins helical table. (3) In the Monroe and Turner table, the elements thorium, protactinium and uranium are assigned positions in the "B" groups while from their study of the structure of the atom and in their helical figure they conclude that those elements really are similar to the first three members of the rare earths. In the table herein presented, thorium, protactinium and uranium are listed as belonging to the "C" groups of rare earths. (4) Monroe and Turner assign a definite position to hydrogen, while merely a relationship of hydrogen to both VII A and I A is designated in the present table.

Use was made of this table the second summer session (1926) at the University of Nebraska by Prof. Cliff S. Hamilton, in his inorganic class there. It is now being used with much success by the designer and author in the beginning chemistry class at Doane College, Crete, Nebraska.

SUMMARY.

A type of periodic table has been described that has been used successfully in teaching beginning chemistry and which possesses the following features:

1. The name O A has been discarded and Transition A adopted as being a better term to describe the inert gases in their new position.

2. The inert gases are used to emphasize the difference of properties of the elements of groups VII A and I A.

3. All the "A" groups are together, as are the "B" groups.

4. Each numbered group of both the "A" and the "B" series occupy the same relative positions, thus making for simplicity and uniformity.

5. A difference in the horizontal spacing of the positions of the elements of the "A" and "B" groups is used to emphasize the "horizontal" relations of the "B" group elements as contrasted to the "vertical" relations of the "A" group elements.

6. A place is satisfactorily provided for the rare-earth elements.

ON MAKING SOUND WAVES VISIBLE.

By H. Lynn Bloxom,

Fort Dodge, Iowa.

Probably many instructors, when approaching the subject of Sound in a modern physics course, have felt the need of some method or device by which they could crystallize in the minds of students, some of the more intangible elements of the subject. When it comes to a discussion of what actually happens when a sound wave strikes a surface, if anything more than a line drawing is to be used, the instructor usually relies upon the water analogy, so frequently used, it is said, for the purpose of keeping the subject from being so dry.

It has been possible for some time now to obtain access to good photographs of sound waves and to have such illustrations printed in the various texts in use, but to actually see a sound wave with one's own eye, has been the coveted privilege of comparatively few. This is not so much because of any complexity of principle involved, as it is because of the velocity of the thing to be observed.

It is well known that the sound wave that emanates from an energetic electric spark has power to refract light, such that when the wave is produced between a photographic plate and another spark following instantly, a shadowgraph may be obtained by the flash of the second spark. If the sound producing spark occurs close to one face of a large, long focus lens, with the light producing spark following immediately at one of the conjugate foci, the sound wave becomes visible when the eye is placed at the other conjugate focus. The wave appears as a definite ring on a bright circular field. This is because the eye receives light uniformly from every point on the lens except in the vicinity of the wave, where the normal behavior of light rays is disturbed.

It is because of the relatively high velocity of sound that it is difficult to design instruments that will consistently place between sparks, a time interval sufficiently small to catch the wave before it has expanded beyond the dimensions of the field. Toepler, Wood, and Foley met this difficulty by introducing capacity at the light gap when the two gaps had been placed in series. Sabine used the ball from a high-powered rifle to release discharges for this purpose, with excellent result. Others have applied similar principles to the photography of projectiles

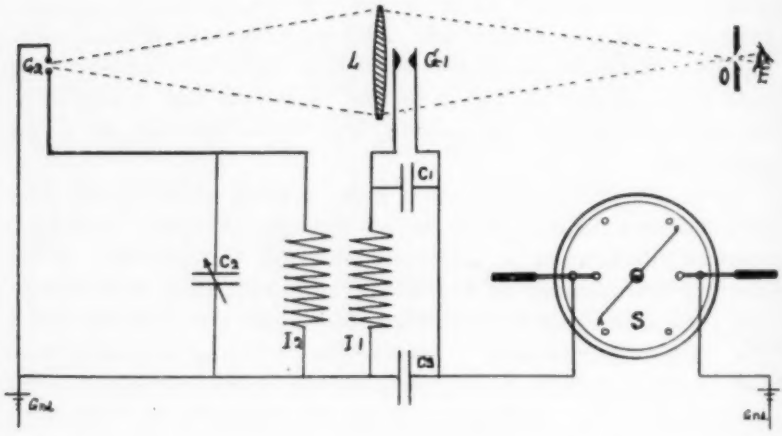
with accompanying phenomena. In most cases, however, the nature of the apparatus necessary for these experiments prohibits its general use in the study of sound, so the writer set about to obtain a similar result with more suitable apparatus. With little departure from methods previously published, an electrical circuit was developed, which, beside being simple in construction and operation, affords a positive control of the time interval between sparks; accurate because all charges function in mutually resonant circuits.

During the course of experiment the writer began to appreciate the brevity of the interval mentioned, as a sound wave is well out of the field of vision in one five-thousandth of a second. However, the experiment was not long underway until a combination of apparatus was devised that gave very encouraging and positive results, the principle of which was remarkably simple and easy to incorporate, but which will not be given space here.

In an effort to obtain even more reliable performance, the experimenter began anew on an entirely different principle; that of discharging a condenser through the primary of an air-core transformer to produce sound, obtaining a discharge from the secondary by induction to produce the light by which the wave might be seen. The success of this arrangement was not evident at first, as the noise of the spark was diffused by oscillation. The necessary sound was restored by shunting the primary gap with another condenser of equal capacity, which of course changed the behaviour of charges moving in the primary circuit—to be explained later. After a little experimenting the arrangement shown in the figure was finally evolved.

In the figure, L represents a 10 cm. lens, having a focal length of 50 cm. The distance O-L is therefore approximately 100 cm. C1 and C3 are condensers having a capacity each of .0017 MF.; sections from a Murdock Transmitting Condenser served the experimenter. C2 is a variable condenser. For the experiment a book-leaf type of condenser was improvised from plates of metal and glass to serve as C2. A variable radio transmitting condenser immersed in oil would probably be ideal for C2. I1 and I2 are coils inductively coupled as illustrated, each having approximately 1,500 turns of wire. Radio coils of the honeycomb type were available and worked nicely after having been imbedded in paraffine to prevent discharging across turns. Honeycomb type of winding is not ideal for this work, however.

G1, the spark gap where the sound is created, is located near the center of the lens as shown, and is constructed so that light does not reach the eye, E, from that source. G2 is an adjustable gap located at one of the conjugate foci of the lens where the flash is made that illuminates the wave and field. O is a small hole in a dark screen, placed at the other conjugate focus. Its service is to locate the position for the eye and create contrast between the field and the wave by excluding rays of light that are refracted by the areas of distortion in air due to sound.



The operation of the circuit may be summarized as follows: C1 and C3 become charged simultaneously with electricity from the static machine, S. When a certain potential is reached, the charge from C1 jumps the gap at G1 where a sharp sound wave is generated. C3 cannot expend much of its energy in this discharge because of the high impedence of I1, but its charge surges through I1 to C1 immediately after, inducing a current in I2 which discharges at G2. The flash of light emitted at G2 is thus made to follow the discharge at G1 by a minute fraction of a second, subject to the laws of induction, and so catches the wave for the eye, while it is still near its source. The interval between discharges can be varied of course, by any change that affects the natural period of the combination, and that is best done by varying the capacity at C2.

When the eye is placed near O, where the rays from G2 are brought to focus, light of equal intensity approaches the eye from all parts of the lens except where refracted by the wave. Hence the field is annular and the same size as the lens. The wave may appear brighter or darker than the field, depending upon the intensity of the wave, the distance O-L, and the adjustment of O.

By using the electrical combination described, all troublesome oscillation was eliminated. The current in the primary was practically unidirectional and that in the secondary was rarely more than a half-cycle of alternating current as judged by the effect of the discharge on the position of the wave. In fact when the circuit was put in operation, all being in adjustment, the waves appeared with remarkable regularity and uniformity with respect to size, and when using the lens the color of the field and the wave projected upon it was a combination of sufficient beauty to divert the scientific intentions of anyone the least sensitive to things so remote from data and formulae. The distribution of color in the field was determined by the adjustment and size of O. O was approximately 1 mm. in diameter. In some of the experiments a concave mirror, ground and silvered by the writer, was used in place of the lens, to eliminate color. An iron core inserted in the transformer seemed to keep the discharge at G2 more constant when a great range of capacity was to be used at C2 for the purpose of studying the wave in various positions.

The writer had access to an old X-ray static machine, which he had put in repair, and he used it as a desirable means of charging the condensers. Rapid discharges of great intensity were obtained for this work however, by blocking the vibrator of an induction coil so as to make continuous contact and operating the coil with city current, in series with an electrolytic interrupter devised in the laboratory. The output of the coil was thus multiplied enormously. Many things interesting and important but incidental to the experiment, might be said, but the original object was simplicity and it is sufficient to say, that anyone with average ingenuity can collect, build, and organize materials for this experiment and in it will find a wealth of beautiful demonstrations of reflection of sound from planes, open and closed surfaces, refraction of sound, etc. With slight variations images can be obtained on a ground glass and photographs may be made.

The writer submits the results of this experiment to the great fraternity of science teachers, that vision may be more universally applied to the study of that with which the auditory sense has long been acquainted.

FAMILY HISTORY OF THE CHIGGER.

One of the greatest little killjoys in all out-of-doors is the chigger. Dr. H. E. Ewing, of the U. S. National Museum, has laid bare several chapters in the life of this pestiferous little beast whose habits, all but its bite, remained for a long time a mystery to science.

What eventually proved to be the adult form of the chigger was known to entomologists as Trombicula, a harvest mite that lives in the soil. Finding this mite frequently associated with the tiny red larval form familiar to the picnicker in the woods, Dr. Ewing suspected its identity. He collected a number of Trombiculae and bred them in captivity. The resulting young were the characteristic red chigger about one-fiftieth the size of the adult mite, which is orange red in color and about as large as the head of a pin.

From the chigger stage of life the insect passes first into the nymph stage for a few weeks and then to the adult stage. The adult lives about ten months and is almost amphibious, requiring a great deal of moisture. The indications are that there is but one generation a year, and if the adults can be exterminated by depriving them of moisture, the chigger may be checked. Amother possibility of control is getting rid of the rabbits that are the principal animals that harbor these pesky little nuisances. Snakes are also known to carry chiggers and ought to excite the envy of unfortunate campers for when they periodically shed their skins they shed the chiggers with them.

According to Dr. Ewing's observations on the chiggers that he kept under observation on his own arm, they do not bore into the skin as is popularly believed, and stay "holed up" under one's epidermis until they decay. They take up a good position for sucking at the base of a hair and attach their mouth parts there. They are not capable of actually piercing the human skin in the entomologist's estimation.

The American species has been exonerated from the charge of being a disease carrier. A Japanese variety, however, is responsible for the spread of flood fever, a disease somewhat similar to the Rocky Mountain spotted fever of our own West.

Flowers of sulphur dusted in the stockings and underwear is the best way of keeping chiggers off while applications of benzine will make them loosen up from their entrenched position at the base of the hair follicles, after they have made their presence known.

A salt bath or a bath with strong soap immediately after coming in from out-of-doors will help wash them off while drug stores sell anti-chigger preparations that purport to check the intense burning that follows a severe encounter with the minute pests. People who find that dusting with flowers of sulphur is itself irritating to the skin may find it advantageous to bathe the legs and feet in a solution of the "hypo" used in photography, which golfers in the South say works very well as a preventive. They run three or four inches of water in the bathtub in which they dissolve a couple of handfuls of the hypo crystals and splash the solution over the members that are most exposed to the enemy.—*Science News Letter.*

GRAPHS—THE MOST ENLIGHTENING TOPIC OF ELEMENTARY ALGEBRA.

By Laura Blank,
Hughes High School, Cincinnati, O.

The study of graphs can be made one of the most vitally interesting practical and educating chapters of ninth grade algebra. The subject instills broad interest, information, enlightenment and understanding of matter scientific, civic, economic, statistical current and historical, as it is for the young folk a new vivid displaying or interpretation of facts otherwise unknown, uninteresting and bookish. The boys and girls enjoy the subject, appreciate its worth and put forth more effort and interest in it than in any other topic of elementary algebra, unless it is the study of the right triangle in elementary trigonometry. This latter topic however does not carry with it so many contacts with their other studies, general science, civics, other sciences, and general reading, particularly periodical reading.

Many teachers of algebra, especially of the older school, are not convinced of the merit of the study of statistical and scientific graphs. Strictly speaking, much of it is not algebra, but arithmetic and drawing. Then too, the very lack of laboratory equipment, the mere mechanics of teaching the subject is a handicap, which requires ingenuity, often, to overcome. One must do much planning and put in much time prior to the actual recitation to present before the class graphs that are sufficiently large and accurate to be meaningful and worthy of the time put on the subject. In spite of such obstacles, interest in the subject from the teacher standpoint, methods of presenting it, and sources of material grow for one, from year to year, emphasizing more and more the place of the subject in this branch of the curriculum.

A thorough understanding of the subject requires a degree of maturity not found before the ninth year of school. Moreover it is a topic the understanding of which no educated man or woman can lack and yet be actually informed, in the present day. Then too there is no more fitting place for the subject than in the elementary algebra course. The working out of appropriate scales of values involves much reasoning and judgment, and often an understanding or approach to the study of ratio and proportion. It may involve the use of a protractor and hence arouse or establish concepts in plane geometry. Of

most importance, it can be made to lead to the idea of a function and a variable, if the course is properly planned and worked out so as to become a gradual development.

The very name "graph" with all that it connotes arouses interest. Pupils have known it in the words "geography," "phonograph," "photograph," "telegraph," "graphic" and "graphite," the lead of their so-called lead pencils, and in many other familiar words. Its methods too are not altogether foreign to our pupils, for they have seen the cotton crop of one country represented by the picture of a small bale whereas that of another country is represented by a much larger bale. The navy of one country is symbolized by a small ship, that of another, by a larger ship.

The first and simplest type of graph for study and construction should be the bar graph. It should be pointed out that it is a mere comparison of different quantities of the same sort, coexistent. For example, a bar graph displaying the various populations of several cities or countires, or one representing the summer earnings of several school boys presents vividly and with meaning a set of statistics otherwise dry and uninteresting. The working out of a scale so as to plan such a graph on a certain size paper, so as to throw it as nearly as possible in the middle of the paper, yet so as to use practically the entire paper requires planning and ingenuity which should develop the intellect of a young boy or girl, and which should lead to understanding and appreciation of graphs.

If the instructor is convinced of the theory of teaching the use of the protractor, the circular or disc graph might well be taken up next. The use of this type of graph to represent peculiarly parts of a whole should be brought out. The understanding and construction of the disc graph involves the idea, though perhaps not taught under that caption of ratio and proportion, a very practical branch of arithmetic and algebra. In this connection the subject of budgets should be made vivid and vital arousing interest in civics and further desire to understand and interpret graphs.

The next type of graph for study and construction should be the broken line graph, which presents two sets of statistics or data at various intervals, related, but not necessarily continuous, perhaps even abrupt, one with respect to the other. The high points and low points of such graphs should be studied until

understood. The necessity for working out an appropriate scale on each axis, one probably quite different from the other, the planning of such scales so as to make the graph large enough to present all of the meaning of the mere statistics, even more, because of its very nature, the ability to work out the graph so as to use the whole of a certain size of paper, yet emphasize the more interesting of the two sets of statistics, the selection of a title for the graph, the need for estimating or approximating values or of expressing values in round numbers—all tend to bring out latent ability. Surely this is not merely arithmetic and drawing.

Next in sequence should come the curved line graph, which represents two sets of related statistics necessarily continuous, as for example the thermograph or the profile of a river made from soundings at points, say, ten feet apart, along the bottom. The pupil should be taught to understand and interpret the high points and low points of such a graph, the sections that are horizontal, most nearly vertical, the steep slopes, and rapid rises. In certain scientific or statistical graphs where one variable is time, he might even endeavor to forecast future trends. It might be brought out, at this point, to what an extent such predictions govern modern industries in their planning, purchasing and constructing for future requirements. This latter variety of graph is sometimes known as a demand graph.

The comparison graph is probably the most interesting sort. This kind of graph represents two separate sets of data, yet related, such as the average weights of boys as compared with the average weights of girls at given ages, say, each year. It should be plotted in two colors or in two different types of line on the same axes, using the same scales for each curve. Each graph is studied separately with respect to its general trend, high points, etc. Finally the real purpose of the graph is brought out in a comparison of the two in all of these respects and particularly in any points of crossing, and the interpretation that one may correctly put on such an intersection. A comparison graph representing the earnings and spendings of a high school boy during the year, particularly the situation during the vacation in contrast to that during the school months presents an interesting problem. The same sort of graph showing the receipts and expenses of a certain kind of business during a year, or several successive years, brings out interesting contacts with economics.

The type of graph next in the development, and of the most importance, is the graph for reckoning, which actually is the graph of an equation. This fact, however, should come as an evolution and sort of summary. One might begin with a table of values of simple interest on one dollar at 5% for any given number of years, having the pupils complete the table, then plot it. The use of such a graph, when plotted on a fairly large scale to read off sums of interest or as a rough check on precise calculations, might be pointed out. A similar graph for converting cubic inches to gallons, for working out the schedule of a train running from town to town, for working out the weight of a given volume of water, using the formula, $w = 62.5v$, brings out the meaning of a formula, the method of substituting in a formula, the complete development of a table of related values, and the idea of a function and a variable, though the terms "function" and "variable" need not necessarily be used in class discussion. Another interesting formula, that used for working out the cost of sending a package by parcel post in the third zone, is $c = 2w + 4$, c representing the cost in cents and w, the weight in pounds. The graph of the formula, $F = 1.8C + 32$, used for converting a Centigrade thermometer reading to a Fahrenheit reading, and conversely, is most useful in that it can be read much more quickly than the formula can be solved for a given value.

The character of the "curves" derived from the formulas referred to above might be noted and emphasized. Then a quadratic formula might be presented, the table of values worked out, the graph plotted and the nature of that graph pointed out. This development and the consequent interest and discussion will lead very naturally to the plotting from abstract equations, not meaningful formulas, of straight lines, linear systems and conic sections, though the latter perhaps should be reserved for an advanced course in algebra. This development of the subject explains the use of equation graphs. Teaching the graphic solution of equations, one constantly feels the need of explaining utility for graphs that appear not to be statistical or scientific. Equation graphs seem to be in a sort of air tight compartment separate from the rest of algebra, interesting and unique, yet of no real value. Pupils inquire constantly concerning their real merit and use in the mathematical sphere.

Distribution or frequency graphs represent small groups, subdivisions of larger groups, as opposed to individuals. These

smaller groups are represented graphically. However there is no real need in going into such a discussion as it is rather technical, though growing in use constantly.

In the study of graphs emphasis should be laid on the fact that there are three methods of representing statistics to show relationships, the tabular form, the formula, and the graphic method. These schemes should be discussed and contrasted, the advantages and disadvantages of one set over against those of the others, for at times, one is far superior to the others for a given purpose.

As far as the actual plan of lessons and assignments is concerned, it is well to devote several whole periods to the subject at its first presentation. Later, a part of each bell might be spent on this work, the rest of the period being used for review work or other algebraic work. One graph might be prepared, as study work outside of class, each day by each pupil, several questions being answered on the curve, after it has been constructed. Other sorts of algebraic problems might be prepared too in the same assignment. On some days the pupils might bring in graphs from outside sources, each writing a good English paragraph or two on his interpretation of its meaning in terms of scale, high points, low points, abrupt rises and drops, horizontal stretches, etc., together with whatever economic, historical, civic or other explanation he can make concerning its meaning. Pupils should be instructed to make a collection of graphs from outside sources beginning several weeks prior to the study of the subject. By that means, each pupil will find graphs that will appeal to him. One boy will enjoy graphs showing the weekly batting averages of a prominent baseball team in line for the pennant. A girl will find interest in the study of a baby's increase in weight from month to month under a certain plan of feeding or diet. Pupils appreciate the study of children's weight in terms of their height, and comparing their weights with the ideal or average weight, they work out ideas and plans of hygienic living and eating. For testing purposes, graphs may be constructed in class from new data, the results being graded much as one would a theme in English, on accuracy, general appearance, appropriateness of scale, title, neatness, and particularly upon the interpretation of the curve by the pupil when he has completed it. Again, graphs from outside sources may be exchanged generally, or those brought by the girls, among the

girls, and those by the boys among the boys, each pupil being required to write a brief composition upon its meaning discussing certain topics: scales, high points, abrupt rises, etc., with an explanation, if possible, of the causes of such peculiarities, and possibly a forecast concerning further development.

In this manner the subject of graphs may be studied during part of every algebra period for two or three weeks providing one of the most educative and interesting and live subjects of high school mathematics.

A DENSITY EXPERIMENT IN HIGH SCHOOL PHYSICS.

By G. W. Warner, Crane Junior College, Chicago.

In the high school physics laboratory where density is being taught it is often difficult to find specimens whose correct densities are known. Different blocks of the same kind of wood vary, aluminum is generally impure, brass spheres may have holes drilled thru them for which allowance must be made, solutions vary as the class continues to test them. Another objection is that if the student knows the correct density in advance the experiment loses much of its value.

In order to overcome these objections to the usual method of procedure, the writer asked one of the scientific companies to make up some of the trip balances graduated to read in pounds and decimal parts of a pound, sensitive to one-thousandth of a pound. The specimen, say a regular shaped block of wood, is measured and weighed in both English and metric units and its density computed in grams per cubic centimeter and in pounds per cubic foot. By multiplying the metric density by 62.4 this result is changed to pounds per cubic foot and can be compared with the answer obtained by using the English measurements. If the answers do not check the student soon learns how to find where errors have been made by checking the measurements across from one system to the other.

This plan gives the student a chance to check his own work, provides practice in both systems of measurement, compares the two systems, holds his interest by with-holding the answer until the end of the experiment, saves the teacher's time, and gives opportunity for providing extra work for the superior student by the introduction of specimens of different shapes and of more exact measuring instruments such as the vernier and the micrometer calipers.

A DEMONSTRATION OF THE BROWNIAN MOVEMENT.

By D. C. Barrus, Mount Hermon School, Mount Hermon, Mass.

A convenient way of showing the Brownian movement may be done by examining a drop from a specially prepared emulsion under the high power of a microscope. The emulsion is prepared by dissolving a small piece of sodium carbonate about the size of a pea in half a test tube of water. To this solution add a few drops of olive oil and shake until the emulsion is well formed. Usually this forms with one or two inversions of the tube. Place a drop of this emulsion on a microscopic slide with a cover glass. The slide must be horizontal and a minute or two allowed for the liquid to assume a quiet condition free from currents. Using the high power of the microscope one can observe the very smallest globules to be in the state of constant quivering, which constitutes the Brownian motion.

TEACHING SCIENCE TO GIRLS.

By Herbert L. Pierce,

Beloit Vocational School, Beloit, Wis.

There seems to be an assumption on the part of public school teachers that science is primarily a subject for boys and that in cases where it must be taught to girls, about all that can be done about it is to flounder along through, hoping for (but of course not expecting) a spark of interest.

The argument is advanced:

First: That boys have a "scientific" mind which they have inherited through thousands of years.

Second: That in all their daily contacts since babyhood they have played, thought and lived in a field of natural science; and

Third: That throughout his life the boy will be called upon to use a knowledge of general science.

Let us look over these points.

First: I do not believe a boy has a scientific mind; he may have a mechanical mind but I doubt if even that is entirely an attribute of sex.

Second: Perhaps the boy does have a daily contact with natural science through childhood. But how about the girl? Doesn't she play with the small ball, ride on the same sled, see the same natural phenomena? And a little older doesn't she see the bread rise, watch the water boil, use the lime, lye, soap, soda, salt, mild acids and a thousand and one things that are explained and accounted for in natural science?

Third: Who will have the greater use for a knowledge of science, the man who sells auto accessories or keeps books or the woman who washes clothes, cooks food, cans food, removes stains, buys cotton, silk, woolen and linen cloth, uses levers and wheels, in the shape of can openers, scissors and a multitude of household appliances?

Granted, then, that a girl's nature is not completely foreign to science, let us see if it may not be possible to give our instruction in a way that will attract her interest and attention. Remember we've been applying our teaching to the boy's experience to capture his interest; now we're going to direct our efforts toward attracting the girl. To do that we must enter her experience and work among her interests. Let us see how we can do that.

First of all, consider the field of cloths and materials. It is

unnecessary to say that those things hold a girl's interest. And the things we can do are legion. Let me illustrate with one or two or three. Many more you can find if you wish.

EXPERIMENT A.

Have your pupils bring small pieces of colored dress goods; cottons, woolens, rayons, silks. Dampen these thoroughly and place in an open glass jar. Cover the jar with a cardboard having a small hole punched through with a pencil.

Set up a gas generator with magazine dioxide and hydrochloric acid to produce chlorine gas which is carried to the glass jar. Let the class observe which materials are fast color; which fade and which do not. Keep samples of the originals for comparison. Vary this if you wish by using the same procedure to remove stains.

EXPERIMENT B.

Secure samples of cotton, wool, silk and linen. Let each pupil prepare a chart something as follows:

TEST	COTTON	WOOL	SILK	LINEN
BURNING				
CHEMICAL				
MICROSCOPIC				
MESC.				

Now burn small cuttings of each material letting the pupils observe (1) Slow or quick flame, (2) Color of flame, (3) Odor, (4) Nature of ash remaining. Let these observances be placed in the proper place in the chart.

Next mix a dilute solution of sodium or potassium hydroxide (4 tablespoons to 1 pint water) and boil clippings of cotton and wool. Enter the results in the chart.

Now place clippings of cotton and wool in hydrochloric acid and enter the results.

If a compound microscope is available observe threads of each material and sketch the characteristics of each in the proper chart squares. Other tests may be found and added to those

mentioned but these few will serve to illustrate my point.

It is unnecessary to go into further experiments in detail. Suffice to perhaps direct your attention to some others that will most certainly command interest and attention.

1. Testing and filtering of water.
2. Hardness and softness of water.
3. Analysis and preparation of soap. Making medicated, perfumed, beauty soap.
4. Action of soap and soap powders.
5. Chemical tests for borax and carbonates.
6. Removing stains.
7. Testing for carbohydrates and proteids.
8. The starch test.
9. Testing for fats and for sugars.
10. Testing for alum, calcium, tartrates, sulfates and salts.
11. Artificial coloring.
12. Milk and butter and milk preservatives.
13. Test the quality of vinegar.
14. Testing extracts, olive oil, etc.

BOB WHITES ELIMINATE POTATO BUGS.

In recent years farmers of Ohio have noticed a marked decrease in the number of Colorado potato beetles, the pest that so seriously interfered with the potato crop a few years ago. In commenting on this Professor E. L. Moseley, head of the natural science department of the State Normal college at Bowling Green, writes in the *Toledo Blade:*

"This summer, while cutting tall weeds near a patch of potatoes, I discovered a Bob White's nest. Then it occurred to me that these birds should be given credit for having accomplished what the farmer, unaided, had failed to accomplish in 50 years of warfare.

"Observations of potato patches on other farms have borne out this view. Many farmers report that the beetles have been so scarce the last few years that it has been unnecessary to spray for them. Others have noticed that when they planted potatoes near the intersections of public highways the vines were eaten by beetles, but when planted near the woods they were not molested. Some have noticed that the Bob Whites spend much time in the potato patch and have watched them going along the rows picking off something from the vines, presumably insects.

"In cities, where these birds are scarce, potato vines are still infested with bugs. In the country, close to the Chicago Pike, where the Bob Whites would not be safe I noticed a small patch of potatoes on which were thousands of the insect pests.

"The Hungarian partridge, which has multiplied in many places in Northwestern Ohio in the last few years, has probably helped to consume the potato beetles. The rose-breasted grosbeak has long been known to feed on these insects, but grosbeaks are scarce.

"The Bob Whites, or quail, because they are now so numerous, so tame and so persistent in their search for the bugs, deserve most of the credit for this long-needed farm relief."

THE USE OF DOT MAPS FOR SHOWING DISTRIBUTION OF POPULATION.

By William J. Berry,

State Normal College, Natchitoches, La.

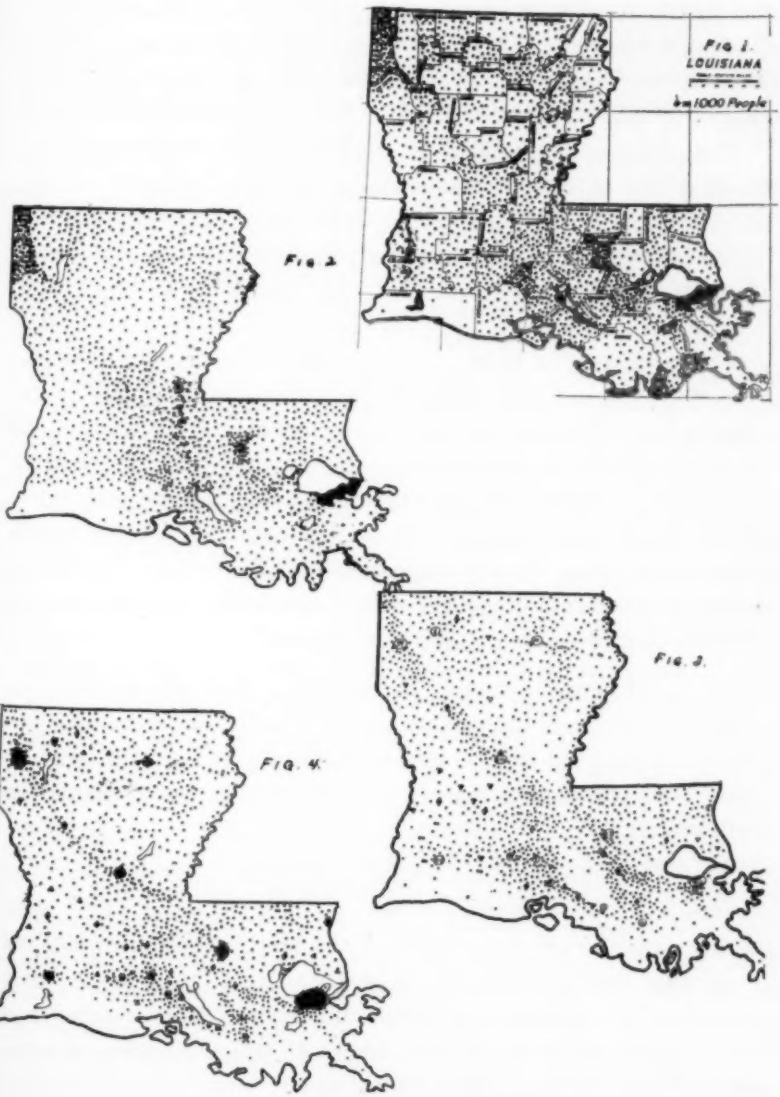
The dot map has proved to be a most satisfactory means of showing graphically any phase of commodity or quantity distribution. This type of map, or more properly graph, is easy to make and requires but little apparatus. It is capable of showing to a better advantage than any other means in common use different degrees of variation in distribution from place to place. It can be used effectively in showing anything that can be stated in terms of units of quantity within a given area. The dot map, very probably, gives a better and more easily understood visual impression than any other type of graph that is useful for the same purposes.

The accompanying dot maps are submitted to illustrate a few schemes for showing distribution of population. Some of them are intended to show imperfections that appear very often in maps of that kind. All of them show schemes that may be useful for some purpose or other.

The population of Louisiana is taken for various reasons. Louisiana has a considerable range in density of population from place to place. There is in one parish (county) a city of almost a half million people, while another parish has less than four thousand. In the prairie parishes the population is fairly evenly distributed throughout, while within the parishes having both hill and valley lands, the density is much greater on the river bottoms than on the uplands nearby. There is likewise an uneven distribution in the river parishes for the people live almost exclusively on the natural levees of the streams. A further contrast is brought out in the low-lying land along the gulf where marsh conditions almost preclude habitation.

Figures I and II show the dots representing the population for each parish evenly distributed over the parish area. These figures are very little, if any, improvement over the type of map, very commonly used, which represents the densities by lines of different heaviness. This way of distributing the dots is rarely employed by geographers for it does not take cognizance of the influence of environmental conditions, but rather merely graphs the statistical data at hand. Figure I has an additional imperfection in that it has a considerable amount

of detail that tends to decrease the usefulness of the graph. The parish names and boundary lines are shown. In some cases where the name is long and the parish small and irregular in shape, the detail gives the impression that the density of population is much greater than it actually is. A comparison of the small parishes, Ascension, West Feleciana, or St. John



the Devine, with the large parishes, Winn, Union or Vernon show this very clearly. If the dot map were to give accurate rather than approximate information, the parish names should be given, but this is not the purpose of the map.

Figure III shows the dots placed over the map very much as they should be to represent the location of the people of the state. The influence of the natural environment is shown in the closely spaced dots representing the parts of the state where there are streams. It would not be amiss to show these streams on the map, but if they were shown it would be best to show them by blue lines so as not to interfere with the purpose of the map.

The problem of how best to show cities on a dot map is not an easy one to solve. New Orleans has approximately a fifth of the people of the state, yet it would be almost impossible to represent that city by a cluster of dots which would accurately show its relative importance. A scale which would make that possible would leave other sections either entirely without a dot or with too few to give a good visual impression of the distribution of population within those sections of relatively sparse population. Showing the cities by means of circles and numbers as in Figure III is quite satisfactory for graphing rural populations, but ordinarily the dot clusters of Figure IV are preferable. In the latter the clusters show up well enough to give an adequate visual impression of the importance of the cities. Louisiana has an average population of 40 persons to the square mile, or 30 excluding Shreveport and New Orleans.

Of the different schemes Figure IV is doubtless the best to give a quick visual impression of the distribution of population. Figure III is good for showing rural population, and it is somewhat more accurate, but it does not convey the information so readily.

The dot map does not pretend to take the place of a table of census statistics and so it is best to omit all details that tend to discount the graph function of the map. A separate outline map may well accompany the map so that any person may refer to it for names of political units or any other feature not directly pertaining to the distribution of the population or commodity that the map portends to graph.

THE VENUS-FLYTRAP (DIONAEA MUSCIPULA ELLIS).

By W. B. McDougall,

University of Illinois, Urbana, Ill.

In limited areas of the coastal regions of North Carolina and South Carolina grows a curious little plant which is found, in a state of nature, nowhere else in the world. This is the Venus-Flytrap, so called because the blade of each leaf is modified into a trap by means of which insects of various kinds are caught. The generic name, Dionaea, is derived from that of Dione, the mother of Venus. The plant was first discovered by John Bartram about 1765 and specimens of it were sent by him to England where it was described and named by John Ellis.

The Venus-Flytrap is perennial by an underground stem and has fibrous roots. The leaves which are one to six inches long and partly succulent are all basal and so closely imbricated below as to form a bulb-like structure at the surface of the soil. The petioles are broadened by lateral wings and are the chief photosynthetic organs of the plant. At the upper end the petiole is abruptly contracted to a narrow, short stalk to which the blade is attached. In early summer a naked and usually unbranched scape from three to fifteen inches tall, which bears an umbel-like cluster of greenish white flowers, is produced.

The leaf blade consists of two semicircular lobes with a stout midrib between. The margin of each lobe is fringed with cilia-like teeth and on the upper surface of each lobe are three long hairs which are very sensitive to mechanical stimuli. When one or more of these hairs is touched by an insect, or anything else, the lobes come together quickly, the marginal teeth interlocking like the fingers when one's hands are folded; and the insect is held a prisoner. This closing of the trap, to be sure, is not so nearly instantaneous as is that of a man-made steel trap. The movement is a turgor movement, that is, it is due to a sudden change in the water content of certain cells along the midrib. This change in the turgidity of the cells causes the blades to move as though they were hinged to the midrib. It is the same sort of movement as that of the leaves and leaflets of the sensitive plant and the rapidity of movement is quite comparable to what is frequently observed when a sensitive plant is subjected to a mechanical stimulus. In spite of the moderate rate of closing the insect seldom escapes being caught since the marginal teeth which are incurved to begin with, are quickly brought close

enough together to prevent it. The sensitive hair consists of a definite stalk and an elongated distal portion. Just what makes this hair so sensitive and how the stimulus is transmitted to the cells along the midrib are matters that cannot as yet be adequately explained.

Scattered over the upper surface of each lobe of the trap are a number of short-stalked glands. When an insect is caught in the trap these glands are stimulated to secrete protein digesting enzymes and the digestible portions of the insect are thus rendered soluble and are absorbed and used by the plant. After the insect has been digested and absorbed the trap slowly opens again in preparation for the next victim. The whole process, from the time the insect is captured until the trap has opened again, may require two or three days, but several of the traps may contain insects, in different stages of digestion, at the same time, while some others on the same plant will usually be found open. This sort of interrelation between the plant and insects is known as antagonistic nutritive disjunctive symbiosis.

The Venus-flytrap occurs in a savannah type of vegetation where it is a minor element from the ecological point of view but forms societies of greater or less extent. The habitat is somewhat comparable to that of northern bogs. The soil is sandy and mildly acid. Soil acidity tests made in a flytrap society at the edge of a long-leaf pine forest in August, 1926, gave a Ph. value of 6.0. The soil is underlain by a non-draining subsoil and, while the water table may be at or above the surface during portions of the year, the soil may become very dry at other times. All of the plants of the community show xeric tendencies. This is shown in the flytrap by its succulence and by the fact that it has persistent, thick-walled root-hairs. No mycorhizal fungi have been found in connection with the roots of this plant.

The habitats to which this plant has become adapted are of limited extent and the plant is not extending its geographic range, so that, if these habitats should be destroyed or materially changed, the Venus-flytrap would undoubtedly become extinct.

The Swedish Riksdag has passed a bill which reorganizes the system of elementary education in Sweden. The primary object of the measure is to discourage private schools and to extend and unify the elementary public-school system. The bill has been the subject of long and bitter controversy among the political parties of Sweden. —Leland Harrison, United States Minister, Stockholm, Sweden.

THE TEACHING OF PHYSICS.

Extracts from a report by the Educational Committee of the American Physical Society.

[The report from which these extracts are copied was made by Professor O. M. Stewart (University of Missouri), Professor Alpheus W. Smith (State University of Ohio), and Professor W. F. Steve (University of Wisconsin). It was prepared with especial reference to the teaching of physics to students in agriculture, but contains so many good suggestions for all physics teachers that we hope the following sentences will stimulate all to read the complete report which is issued as a supplement to Vol. 1, No. 11, Bulletin of the American Physical Society.—Editor.]

Summary of reasons for greater emphasis on the course in physics

1. The importance of giving greater stress to the student acquiring a thorough foundation as a preparation for scientific work.

2. Methods and principles of physics are being used more and more in agriculture as well as in all biological sciences. The list of topics in physics that students need in their courses is a long one.

3. The course in physics is the only place in the curriculum where the fundamental principles of force, energy, heat, electricity, etc., are taught.

4. A course in physics covers five different branches, mechanics, heat, magnetism and electricity, sound, and light. Several of these are important enough to be given the entire time of the present course.

5. Physics is a hard subject, largely because the student is rushed too rapidly through the work. Not enough time is given for the students to digest the material.

6. It is most important that the student should learn his physics in such a way that it becomes an effective tool. This requires much time in drilling the student on the applications of principles. In most cases the subject is given in such a hurried manner that it is not of great use to most students.

7. Most of the graduates of agricultural colleges become teachers, research men, extension specialists, county agents, or other kinds of agricultural experts. This fact makes the need for a thorough training in fundamental science more important than if the graduates went back to the farm.

SOME SUGGESTIONS ON METHODS OF TEACHING PHYSICS.

The teaching of agricultural students presents many important difficulties. Some of these are common to all courses in physics, but there are others which are special. Agricultural students are usually not interested in physics. A dean of one of the more

important colleges of agriculture stated that agricultural students were less interested in physics than in any other science. Engineering students are as a rule much more interested. They usually realize that a knowledge of physics is necessary in their technical work. Then too their preparation is better. Hence a teacher of physics does not need to pay so much attention to devices for making his work successful when teaching engineering students. But in the case of the teaching of agricultural students the teacher should use every method which will help him.

So much of little value has been written on the psychology of teaching and so extravagant have been the claims made for the theory of teaching that many college teachers are prejudiced against everything that is written on the subject. There really has not been much written on the specific problem of the college teacher of physics. Good teaching is largely a matter of common sense and industry and the utilization of those practices which have resulted from the observation of successful teachers of physics. There is therefore not much that should be called to the attention of the physics teacher in this report. Indeed if he has not learned from his years of observation as a student and as a teacher a great deal about teaching then it is hopeless to attempt in a few pages to give him the fundamental principles of good teaching. However, it is thought advisable to state here a few points which are usually not given the attention which they deserve.

The teacher should have in mind the aims of the course and the aims of the student. It is very important that a teacher should have definitely in mind the aims or purposes of any course which he gives. If he does not have these clearly in mind he may fail in achieving one or more of the important purposes, or he may waste time by using material or methods which have no bearing on the purpose of the course. In addition to having definite aims himself the teacher should know what is the probable aim of the student. For good teaching usually means that the teacher begins his work with the aim of the student in mind and gradually leads the student to have other and often higher aims. It is very important that the aims of teachers and those of the student should be as nearly identical as possible. Let us first consider what are those aims of an elementary course in physics which are quite generally accepted by teachers of physics.

One can find many different statements of the aims of an underclassman course in physics. Most of these can be put in

one of the following groups:

1. Training in the scientific method of thinking, especially in quantitative methods.

2. Imparting a knowledge of those laws, facts, and experimental methods that will be useful to the student.

3. Training in special fields, such as observation, imagination, inititive, and ingenuity. (One of the relatively recent conclusions of psychologists is that such training is not general. A training in observation in physics does not necessarily train one to be a good observer in other fields. These qualities are far more specific than we formerly thought they were. Hence this group of aims is not given today the same relative importance as formerly).

There are others but these are sufficient for the purpose of this report. It is not worth while to try to state which of these is the most important. In general, they go together. For example, we can not teach the first to the student without also teaching the second.

The aims of the student are frequently quite different from those of the teacher. In the colleges of engineering physics is usually accepted as a very important element. The teachers in the advanced courses continually use facts and principles of physics. This is so well known that in many engineering colleges there is a tradition among the students that it pays to understand physics. In such schools the aim of the student is usually the second one, that he wants useful information. It is much more difficult to state definitely what the aim of the agricultural student is. Too often he takes physics because he must have it to get a degree, it is a necessary evil to be disposed of as best he can. Such a student should be supplied as quickly as possible with a worthy aim. The easiest one to give him is that it is worth while to study physics because the information is of much value. This can be done by using illustrations drawn from things with which he is familiar, and about which he knows that he needs more information.

Too many teachers do not appreciate the above point. Too often they assume that students have the same motives and the same interests that they had when they were students. It is hard to realize that there is such a great divergence of aims and interests. The formulas and methods that appeal to a specialist often have no meaning whatever to the average student. Teachers should realize fully the importance of teaching beginning

students by methods entirely different from those used with advanced students. To choose examples that will illustrate the principles of physics and yet deal with facts with which the student is familiar requires careful planning on the part of the teacher. The significance of the principles of physics as applied to the daily life and thoughts of the student must be made clear. When this is done not only are the principles clearer to the student but he has been supplied with a worthy aim or motive. This is nothing more or less than what is sometimes called "selling the subject."

There are teachers who say that we are lowering our standards in adopting such methods, that we should hold our students up to higher ideals. This attitude is often taken by teachers because they do not understand clearly just what it is that is advocated. It is not desired to cheapen the course by introducing spectacular experiments, or by using illustrations that are merely interesting. The purpose is to teach fundamental principles of physics by means of illustrations drawn from things with which the student is familiar and in which he is interested. It is not, when correctly done, a lowering of standards, for the principles can be taught with even more thoroughness when we begin with familiar facts and methods than when we begin with more abstract things. In fact this method encourages less superficiality on the part of the student than the other methods. No one need worry about making physics too easy for it is a hard subject to many students, in fact it is often too hard. In many instances, the average student digests very little of the subject. It is a mistake for teachers to overlook the importance of supplying a motive to the student. It is almost a necessity that it be done. For if it is not the teacher's success is made much more difficult.

The aims of the faculty which requires the student to take physics should also receive consideration. Some of the agricultural teachers would stress the first of the aims given above. But probably most of them would state that the second aim was more important. Many of them would probably argue that the physics teacher should give facts and laws which would be useful to the student for, in so doing, the work not only makes a more immediate appeal to the student but these facts and laws are as well suited as any others for training the student in scientific thinking and in accomplishing the other ends which the teacher may have in view.

It should be clear, without going into further details, that the

teacher of physics should pay a great deal of attention, especially in the first part of the course, to teaching facts and laws that are useful to his students. Teachers and textbooks of physics are prone to use illustrations drawn from engineering fields. These illustrations often mean very little to a student who is not familiar with mechanical devices. It is very important that each teacher should collect for use in the class room a fund of illustrations drawn from daily life, things of household interest, things seen on the street, the weather, and in general those things about which the student already knows something. Applications to simple agricultural phenomena should be used freely. In this way the teacher can soon build in the mind of the student a definite interest and aim in the course. While the teacher is doing this he can also develop the other aims which he thinks are important.

Each teacher must be certain that he understands the attitude of the student. Then he must give the course in such a way as to give the student a definite aim and interest. Then and then only can he succeed in accomplishing what he regards as the chief purposes of the course.

Generalizations must be made only after a large number of specific cases are understood. In the usual method of acquiring knowledge one learns first a large number of facts. Later he may be able to generalize and to employ more or less abstract methods of reasoning. He does not begin by learning generalizations. To realize that this is true one has only to recall his own training. Generalized thinking is so common with physicists that often they do not realize how vague it may all be to students. Too often the student of physics is introduced to the subject by being confronted with definitions or general statements that he cannot understand. Generalizations should not be made until the student has first learned a number of specific cases. For example, in understanding even so simple a law as the Newtonian law of gravitation, attention should be first called to the fact that the earth attracts bodies on its surface, that it attracts the moon, and then the student should learn something of the experiments showing the attraction between other bodies. He can then understand the generalization as stated in Newton's law. One teacher year after year asked a student who had just "recited" Newton's law what the law meant. The usual answer was that it meant that the earth attracted the moon (this probably was

the illustration used in the textbook.) He then asked the student, "Does this piece of crayon attract this other piece?" A common answer was "No." Yet that student had just stated that "every particle in the universe attracted every other particle. . . ." Nearly every teacher has observed a similar inability of students to apply generalizations. The teacher must clearly appreciate the fact that a general statement means nothing unless it calls to one's mind a large number of specific cases.

In selecting the specific cases that should be taught the teacher should select those with which the student is familiar and those in which he is interested. In doing this the particular interests of the student must be kept in mind. The teacher must be certain that the cases selected as illustrations must be concrete to the student. Much of our demonstration apparatus is not concrete to the student. He never saw or heard of it before. He does not understand it. How can the machine illustrate a principle when he does not understand the machine? The mere seeing of a piece of apparatus on the lecture table does not always make the apparatus concrete. Many teachers have marveled at the inability of students to recall accurately the result and the purpose of a particular demonstration.

In teaching a general principle the teacher should begin with the concrete and should give the student clear ideas of the entire field before the generalization is given.

Students learn to apply generalizations only by learning a number of specific applications. It is a very common mistake to assume that the student can learn for himself how to make the applications of a general principle. The inability of students to make applications of general principles to new problems is the basis for much of the criticism by other departments of the teaching of physics. There seems to be only one way to train students to make applications of a principle over a wide field and that is by pointing out to the student many applications and in encouraging him to find others. These applications should be so chosen that they cover a variety of special cases. Then when a new problem comes to the attention of the student he is more likely to find in the new problem some element common to another case which he understands and thus will be able to find the correct principle to use. A student might not apply the principles of adiabatic heating or cooling of gases to atmospheric currents unless he knew some related application. There is no

doubt that the ability of a student to apply his knowledge of physics is one of the most valuable things he can derive from the course.

Students learn a generalization by learning specific cases. After they understand the generalization they learn to apply it by learning a number of applications. To be able to understand and to apply a principle the student must begin with the concrete and must end with the concrete.

Physics is best taught in small classes. It is a common way of teaching elementary classes in physics to use simultaneously three different methods of presenting the subject: (1) demonstration lectures given to a large group, (2) recitations and quizzes in small groups based on lectures and textbook assignments, and (3) individual laboratory work. The distribution of time between these different methods varies widely. But the reports received from teachers in charge of the course of physics given to agricultural students show that the first method dominates in a number of institutions. The lecture method with elementary classes is an inheritance from the time when we had no textbooks. The continuation of its use is by no means a proof of its efficiency. Certainly it is well worth while for teachers to consider whether the lecture to a large group of students is desirable, especially when that group consists of students who because of deficient preparation or lack of interest are difficult to teach.

The advantages of giving formal demonstration lectures are obvious and well known. Undoubtedly it saves the time of the teaching staff. On the other hand the pedagogical disadvantages of teaching underclassmen in large groups by the lecture method are very serious. So serious are they that an attempt will be given here to point out some fundamental considerations.

The various methods of teaching may be divided into two classes: (1) the "telling" method, and (2) the "developing" method in which an attempt is made to develop the student's reasoning power and his ability to apply the principles he has learned. In deciding which of these two methods should dominate one must again consider the purpose or aims of the course. By the first method the facts and principles of a subject can be taught. But this is not all that is desired in a course in physics. The investigation made by a former Committee showed that a majority of teachers of physics in engineering schools believed that the most important aim of a course in physics should be to

train students in scientific habits of thought. It has been pointed out before that it is of great importance that a student learns how to apply the principles of physics to new problems. Independently of how we classify our aims, there are some very important features, perhaps the most important, that cannot be taught by the lecture method. Students learn how to think only by thinking. They learn how to apply principles of physics to new situations only by doing it. They need a great deal of help and guidance in learning to apply these principles. They need a method of teaching which can be used only in small classes.

If a student is to receive this type of training that is so valuable, not only must the class be small, preferably about fifteen, but the teacher of that class must use the "developing" method. He must not do most of the talking. He should not merely quiz or ask students to "recite." He should expect the students to discuss things. Where textbook assignments have been made time should not be wasted duplicating what is clear in the textbook.

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE.

Being some observations of the great and the near-great on the nature of the several sciences and on the art of living in general, preserved occasionally without prejudice but reproduced always with mental reservations.

By Duane Roller.

Very late in life, when he was studying geometry, some one said to Lacydes, "Is it then a time for you to be learning now?" "If it is not," he replied, "when will it be?"—*Diogenes Laertius, Greek author, in The Lives and Opinions of Eminent Philosophers.*

> The starving chymist in his golden views
> Supremely blest, the poet in his muse.
> —*Alexander Pope, English poet and critic.*

It is certain that a serious attention to the sciences and liberal arts softens and humanizes the temper, and cherishes those fine emotions in which true virtue and honor consist. It rarely, very rarely happens that a man of taste and learning is not, at least, an honest man, whatever frailties may attend him.—*David Hume, English historian and philosopher.*

They spell it Vinci and pronounce it Vinchy; foreigners always spell better than they pronounce.—*Mark Twain in The Innocents Abroad.*

Steam is no stronger now than it was a hundred years ago, but it is put to better use.—*Ralph Waldo Emerson.*

It is the customary fate of new truths to begin as heresies and to end as superstitions.—*Thomas Henry Huxley in The Coming Age of the Origin of the Species.*

Grandeur consists in form, and not in size; and to the eye of the philosopher, the curve drawn on a paper two inches long, is just as magnificient, just as symbolic of divine mysteries and melodies, as when embodied in the span of some cathedral roof.—*Charles Kingsley.*

CONDUCTING A SEMESTER'S REVIEW IN NINTH-YEAR ALGEBRA.

By Kitty Turley,
Mexico, Mo.

Teachers usually plan their reviews with high hopes and with much enthusiasm, but often they are keenly disappointed in the response of the pupils to the presentation of the review. To the pupils the review merely means going over some old work quickly.

At the close of the first semester, I followed a plan which brought me gratifying results. The pupils unsolicited made such remarks as these: "This was fun," "This was interesting," "I like this way" and even "I've learned more these three days than during the entire semester!" This last remark was a decided exaggeration, it is true, but it expresses the interest aroused in the pupil.

The plan was simple. I had one of the pupils make mimeographed copies of the review outline which I had prepared. This outline consisted of three parts: the terms used during the semester, the mechanical processes studied, and one of each type of verbal problems studied. The outlines were put into the hands of the pupils several days before the beginning of the review. They were told to begin the review at any time convenient to them. The class was divided into two teams, chosen by leaders whom I had selected on the basis of highest grades made during the semester. They were told that scores for each day's work would be kept.

For the first day I had prepared and written on opposite blackboards, two similar sets of completion-type questions covering the terminology of Algebra we had been using. The teams were told to assemble at the boards and these instructions were given:

"Twenty minutes will be allowed for filling in the blanks. The leader should step aside and permit others to answer the questions. He should watch carefully for errors and correct them. Any member of the team may correct an error also. You may discuss with one another any answer on which you disagree. Work for a perfect score."

At the end of twenty minutes all pupils except the leaders were asked to return to their chairs. Leader of team Two was asked to check all errors in the work of team One. All pupils

were asked to watch the checking and to suggest any corrections or discuss the checking. The number correct was the score for team One. Leader of team One checked the work of team Two in a similar way.

The second day I had written on the boards two similar sets of multiple-choice questions, covering all the mechanical processes studied during the semester. The work was conducted as it was on the first day. Scores were announced at the close; also the total scores for the two days.

The third day we were reviewing verbal problems, and as they required more board space I had only one set prepared and written on the front board. Spaces for answers were marked off on opposite boards and the leader's name written at the top. These instructions were given:

"Solve these problems on paper at your chairs. Consult one another, if you wish, before recording your answer on the board. Make changes in the answers if you wish."

At the close of time allowed I checked the answers. Several of the problems that had given special difficulty were solved at the board by volunteers. The scores for the day and for the three days were announced.

REVIEW FOR FIRST SEMESTER'S WORK IN ALGEBRA.

Use the index in your book to find what you want.

I. Make list of these, explain each or give an example of each:

monomial
Al-jebr
equation
factoring
identity
consecutive integers
negative quantities
descending powers
prime factors
radical sign
literal equation
binomial which is the difference of two squares
substitution
polynomial to be factored by grouping
binomial which is the sum or difference of two cubes
Newton
ascending powers
signs of aggregation
coefficient
exponents
Harriot
index
positive quantities
Oughtred
Vieta
quadratic trinomial
literal exponent
trinomial square
axiom
Wallis

II. Study the following paragraphs in your text and solve one of the exercises indicated:

1. Order of fundamental operations, page 13.
2. Addition, page 22.
3. Subtraction, page 25.
4. Multiplication, page 27.
5. Division, page 29.
6. Removing parentheses, page 65.
7. Division of one polynomial by another, page 91.

8. Special rules of multiplication:
   (a) The square of a binomial, page 105.
   (b) The product of the sum and difference of two terms, page 107.
   (c) The product of two binomials having a common term, page 109.
   (d) The product of two binomials of the form $(ax+b)\ (cx+d)$, page 110.
9. General directions for factoring, page 135.

III. Study until you can tell readily:
1. The squares of numbers 1 to 25.
2. The cubes of numbers 1 to 5.
3. The roots of these squares and cubes.

IV. Solve the following verbal problems:
1. Problems involving two or three numbers, page 47, 13.
2. Rectangle, page 85, 29.
   Page 47, 10.
3. Consecutive numbers, page 48, 20.
4. Age, page 84, 20.
5. Coin, page 86, 35.
6. Problems, involving only one number, page 61, 9.
7. Travel, Page 102, 7,
   Page 103, 18.

TEST I.

(1) [ ], { }, ( ), and ——— are *signs* of *aggregation.*

(2) They are called individually *brackets, braces, parenthesis, bar.*

(3) $+6b^2$, $+2b^2$, $+15b^2$ are *similar* terms. They are also *positive* quantities.

(4) In $7m^3$, 3 may be called the *exponent* of m, or *third power* of m or the *third degree* of m.

(5) 2, 4, 6, 8, 10 are *consecutive even integers.* In Algebra we have x, $x+2$, $x+4$ to correspond to 2, 4, 6 in arithmetic.

(6) 1, 2, 3, 4, 5, are *consecutive integers.* In Algebra we count by ones also. The integers in Algebra are expressed by x, $x+1$, $x+2$, etc.

(7) Odd integers are counted by 2's both in arithmetic and in Algebra. In arithmetic they are *1, 3, 5, 7;* and in Algebra they are $(x, x+2, x+4, x+6)$.

(8) (r^2+5r+6) is a *quadratic trinomial.*

(9) $-7my$ and $-7m^2y$ are *dsssimilar* terms. They are also *negative* quahtities.

(10) (m^2-n^2) is a *binomial,* the *difference* of *two squares.*

(11) In $6m^ry^s$, r and s are called *literal exponents.*

(12) Algebra comes from the word *Al-jebr* which was first used as a part of the *title* of a book.

(13) In 12edy, 12 is the *numericol coefficient.*

(14) 6m and $(1+2r)$ are *factors* of $(6m+12rm)$.

(15) $d+3-7=3+d-7$ is an equation of *identity.*

(16) In $x-y=15$, 15 is the *right member* of the equation.

(17) *Vieta* is often called the founder of modern Algebra.

(18) The cross as a sign of multiplication was first used by *Harriot* and *Oughtred.*

(19) $\sqrt{\ }$ is a *radical sign.*

(20) The two steps in checking an equation are *substitution* and *simplifying.*

(21) $11x^4+7x^3+21x^2-6x$ is arranged in *decending order.*

(22) A product is obtained by *multiplication.*

(23) In division the result or answer is called the *quotient.*

(24) The authors of our text are *Hawkes, Luby, Touton.*

(25) The three quantities in a travel problem are *rate, time,* and *distance.*

(26) Division is checked by *multiplying* the *quotient* by the *divisor.*

(27) $x^2-3\sqrt{b+c+y}$ is a *trinomial* because it contains *three* terms.

(28) The distance around a rectangle is called its *perimeter.*

(29) If a factor is divisible by only *itself* and *one* it is said to be a *prime* factor.

TEST II.

(1) $3cm^2-6m^2c+2cm^2=5cm^2,\ c^4m^6,\ -cm^2.$

(2) $6bc^2y$ from $-2bc^2y=4bc^2y,\ -8bc^2y,\ -8.$

(3) $12c^2m^3$ times $-c^2my=11c^4m^4y,\ -12c^4m^4y,\ -12m^2.$

(4) $15c^6b\div3c^5d=5c,\ 12c,\ 5cd.$

(5) Remove parentheses

$7(m-1)-(2+m)+6=\begin{cases}7m-1-2-m-6.\\7m-7-2-m+6.\\7m-7-2+m+6.\end{cases}$

(6) $\sqrt{196b^4c^2}=\pm13b^2c,\ +14b^2,\pm14b^2c$

(7) If $15x=11$, $x=15/11,\ -4,\ 11/15,\ 1\ 4/11.$

(8) $(m-n)^2=(m^2-n^2),\ (m^2-2mn-n^2)$
$(m^2-2mn+n^2).$

(9) $(b-3c^2)(b+3c^2)=(b^2-9c^4),\ (b^2-6c^4),$
$(b^2-9c^2).$

(10) $(c-6)(c+5)=\begin{cases}(c^2-11c-30).\\(c^2-c+30).\\(c^2-c-30).\end{cases}$

(11) $(c-6)(2c+1)=\begin{cases}2c^3-5c-6.\\2c^2-11c-6.\\2c^2-13c+6.\end{cases}$

(12) $r^my^c.\ 2ry^c=\begin{cases}2r^{m+1}y^{2c}.\\2r^my^{c^2}.\\2r^my.\end{cases}$

(13) If $2cx=b$, $x=(b-2c),\ b/2c,\ 2c/b,\ 2bc.$

(14) If $x=-2$, $x^2-x+2+x^3=12,\ 8,\ -4,\ 0,\ 16.$

(15) $1-25b^2=\begin{cases}(1-5b)(1-5b).\\(5b-1)(5b+1).\\(1+5b)(1-5b).\end{cases}$

(16) $9m^2-42m+49=\begin{cases}(3m^2-7)(3m^2-7).\\(3m-7)(3m+7).\\(7-3m)(7-3m).\end{cases}$

(17) $(a^2-9a+8)=\begin{cases}(a-4)(a-2).\\(a+8)(a+1).\\(a-1)(a-8).\end{cases}$

(18) If $e=-5$ and $r=-7$, $2r-e=9,\ -9,\ 19,\ -19$

(19) $m^3-z^3=\begin{cases}(m-z)(m-z)(m-z).\\(m-z)(m^2+mz+z^2).\\(m-z)(m^2-z^2).\end{cases}$

(20) $3c^2-4c+1=(3c+1)(3c+1).$
$(3c+1)(c+1).$
$(c-1)(3c-1).$

TEST III.

(1) If a train travels x miles an hour and an automobile $(x-y)$ miles an hour, find the difference of their distances in the course of 5 hours.

(2) Find five consecutive numbers whose sum is 70.

(3) A man is four times as old as his son; in 18 years he will be only twice as old. Find the age of each.

(4) A dealer bought 25 dozen oranges for $9.25. For a part he paid 40 cents a dozen and for the remainder 35 cents a dozen. How many dozen of each did he buy?

(5) I have $3.85 in quarters and ten-cent pieces and I have three times as many ten-cent pieces as quarters. How many coins of each kind have I?

(6) Divide 75 into two parts such that one part shall exceed twice the other by 9.

(7) Two trains start at the same time from two cities 450 miles apart and travel towards each other, one at the rate of 50 miles an hour and the other at the rate of 40 miles an hour. In how many hours will the trains meet?

(8) If 5 times a certain number is diminished by 3 and the remainder multiplied by 23, the result is the same as if 7 times the number were increased by 9 and the sum multiplied by 7. Find the number.

(9) An express train, which travels 45 miles an hour, starts 2 hours after an accommodation train, which it overtakes in 4 hours. What is the rate of the accommodation train?

(10) A field is x rods wide and $2x-1$ rods long. Express its perimeter.

NOTE:—Most of these problems were taken from Rushmen and Dence "High School Algebra." Only the first and tenth were original.

BERYLLIUM TO RIVAL ALUMINUM.

Airship frames and light-weight pistons may soon be made from beryllium or its alloys, and this hitherto unknown metal may soon achieve the household familiarity that aluminum has won during the last two or three decades.

Beryllium is a metal about a third lighter than aluminum, but is very much harder, scratching glass easily, like hard steel. According to H. S. Cooper, industrial chemist of Cleveland, Ohio, it is one of the most remarkable of all metals in its elasticity. It is over four times as elastic as aluminum, and 25 per cent. more elastic than steel. And while aluminum corrodes easily on contact with salt water, beryllium shows very high resistance to this as well as to other metal-destroying liquids and fumes. It is light gray in color, and takes a polish like that of high grade steel.

It is chemically related to aluminum, and easily forms alloys with it. One of these, consisting of 70 per cent. beryllium and 30 per cent. aluminum, is one-fifth lighter than aluminum, far more resistant to corrosion, and in tensile strength far exceeds duralumin.

One quality which Dr. Cooper points out may render beryllium especially valuable to the automobile industry. It expands under the influence of heat at about the same rate as cast iron. Thus when used for light pistons inside the iron cylinders of automobile engines it will present far less engineering difficulty than do the present types of light pistons, which expand at a rate different from that of iron.

Beryllium ores are found abundantly both in this country and abroad. At present they are hauled out of feldspar mines in New England by hundreds of tons, but are dumped away as waste.

Although so new industrially that it can not properly be said to have been born yet, scientifically beryllium is an old story. It has been known to chemists for 130 years; Vauquelin, a Frenchman, first indicated its existence in 1797. But until recently it has remained merely a museum curiosity and a laboratory material, because it is so refractory that the cost of getting it in anything like a pure state has been prohibitive. But now that the cost of manufacture promises to be materially reduced by a new electrolytic process, it is probable that it will appear on the market in quantity.—*Science News-Letter.*

HISTORY OF MATHEMATICS IMPORTANT.

The members of the Indiana Section of the Mathematical Association of America think the state board of education is demanding of candidates for mathematics teaching positions too many courses in education and too few in mathematics. It is pointed out that the subject of mathematics loses much of interest and value when it is separated from its history. The section recommends the substitution of a course in the history of mathematics for one of the education courses now required of all students preparing to teach mathematics in the state.

IMPROVEMENT IN EXAMINATION TECHNIQUE FOR TEACHERS OF BOTANY.

By H. M. Jennison,

University of Tennessee, Knoxville.

Abstract.

As the title suggests, the writer offers something in the way of improvement of the traditional written examination. A comparison of the essay type of examination with the newer objective type leaves little in favor of the former where a measure of the student's knowledge of a subject is the chief purpose of the examiner. Several examples of objective tests are given and methods of devising the newer type of examination are discussed in the complete paper. Nearly five years experimenting and use of the newer examination in connection with teaching classes in Botany at the University of Tennessee finds the writer more favorably disposed to the use of this type of examination because (1) it can be made to measure what it is really intended to measure, (2) degree to which personal judgment is eliminated in grading, (3) it possesses reliability in accuracy and consistency of measurement, (4) it may be quickly and easily scored, (5) less fatiguing for student as well as instructor.

Introduction.

Within recent years we have witnessed the publication of many new botanical text books and manuals both in the general field and in special branches of the science. Also, we have at hand other evidence which shows that there has been considerable thought given to improvement in pedagogical methods as applied to the teaching of botany, but it seems that botanists in company with certain other classes of scientists have been rather slow to recognize the fact that the university no longer consists of Mark Hopkins at one end of the log and a student or two at the other. University and college classes, especially those in beginning or fundamental courses, have become larger and larger. That the population at large is not science-minded seems to be a fact and, as would be expected, many college classes include few who are primarily interested in the subject matter of catalogued courses. We find in fact that a majority of the membership of many large classes is made up of persons who are taking a "required science" and it is probably true that certain individuals are more interested in making a good grade than in acquiring a working knowledge of the subject.

Some have met and solved certain of the problems attached to the administration and instruction of large classes, but if it be admitted that we have enlarged and improved some of our pedagogical methods it must at the same time be evident that improvement in examination technique has lagged behind. True, we succeed tolerably well in measuring the accomplishment of the smaller numbers of graduate and undergraduate students whom we are able to measure objectively by oral and other more or less intimate and thorough methods of examination. However, difficulties of determining the measure of achievement of small groups in advance classes is a trifling problem when compared with that which develops when the class is a large one. Improved examination technique such as is described herewith can, however, be used with small classes who elect a course as well as the large groups registered in the fundamental course.

Means of Judging Examinations.

Possibly examinations were the vogue before formal instruction began, but certain it is, that the written examination has been used since antiquity. Until more or less recently, perhaps this type of examination was quite satisfactory but under present day circumstances the age-old essay type of examination adds unnecessarily to the burden of the conscientious instructor. Probably this has been a fact for longer than we suspect. For years students have been asked to define morphology, discuss osmosis, review the steps of photosynthesis—and what-not. For as many years the examiner has been forced to read the lengthy essays of some students in order to discover, if possible, whether or not his student has acquired any knowledge of the topic. The saying of much in few words is an accomplishment few possess. But, assuming that he does discover signs of some know.edge of the topic, how now will he evaluate it? Will he be influenced most by what he thinks the individual should know or by having been put out to find how little of real knowledge he could decipher from the student's hieroglyphics? Regardless of how these questions may be answered it is important to note that the essay type of examination has been shown by competent investigators to be unreliable as means for educational measurement.

Ruch admirably summarizes the criteria of a good examination. He says the examination should possess (1) validity; i. e., measure what it is really intended to measure, (2) reliability;

i. e., measure accurately and consistently, (3) objectivity; i. e., degree to which personal judgment is eliminated in the scoring of the answers, (4) ease of administration and scoring, (5) ease of wide sampling of the subject, and, (6) the examination should be less fatiguing for student as well as instructor to handle than is the essay-type of examination. It has been shown how and where the traditional written examination fails to comply very well with any of these requirements, and the investigator above mentioned emphatically states that a 10 to 20 minute examination of the objective type is very much more reliable than the 5 to 10 question essay examination for which 30 to 60 minutes are allowed. Another of the advantages of the new kind of examination is its adaptability. We find that it may be substituted wherever the essay-type could be used for a botany examination.

At this point the writer wishes to state that he makes little claim for originality in the forms or types of objective examinations discussed below. Possibly our use of the tabular comparison as a true-false test (Illust. 1a) is somewhat of an innovation. The scoring of diagram labeling and the life-cycle charts (Illust. 2A) as recall tests may also be suggestive. Throughout our experience we have been generously advised by professional psychologists and others who have been in close touch with developments in improvement of the written examination. However, we have made rather extensive use of the more reliable test forms already devised. In our experience, the results obtained have been so satisfactory that we are persuaded that many colleagues would be interested. Eventually some may become sufficiently satisfied and will agree with one of our instructors who suggests that the newer or objective type of examination makes it possible to "take the *es* out of *essay*." There are teachers who may have been persuaded to let the objective type of examination alone, being advised that it might be all right for some subjects, but not workable in botany and comparable subjects. To these we offer this summary of evidence to the contrary.

Experience with the Newer Type of Examination.

Our experience with the objective type of examination as a means for measuring the student's accomplishment in botany classes extends over a period of about five years. Some thought was had of giving the objective examination a trial at an earlier date but we were persuaded temporarily that such examinations could not be constructed and used in botany. However, we

decided in self-defense to make a beginning. The turning point came one day when among other things we asked a class to "Explain why protoplasm is sometimes spoken of as the 'living substance.' " An unusual number of strange answers were given not the least startling of which read as follows: "The protoplasm or protoplasts include these parts or organs of the soil and the tissues are built of these cells and the organs are composed of these tissues. All of the plant being made up of these protoplasts which is all of the living matter. For this reason it may be said that the protoplasm is the only living substance in the plant" (!) The next time we formulated the same question thus: "Protoplasm may be called the 'living substance' because it is the only substance known which can build up more like itself from simpler materials," and simply directed the student to indicate whether the statement was true or false. Quickly we discovered a student's failure to grasp the concept given if he marked it "false," or quite as easily his success if he marked it "true." To be relieved or having to peruse such statements as the one quoted above in order to determine that the student had no idea of the correct answer seemed worth while in itself. Early results encouraged us to branch out. Our earliest examinations of the objective type consisted of a considerable number of statements that were either true or false. Since then we have experimented extensively and have, I believe, learned better how to build fairer and more suitable objective examinations. Our limited experience with the objective type of examination seemed to indicate that some students react better to one type of test than another. More or less recently this inference has been satisfactorily proved by experimental psychologists. The use of several types of tests in one examination makes possible greater sampling of the topics assigned. Thus, for one reason or another our examinations have been so constructed as to include four to five or more of the test types given below.

More time and thought is necessary for the construction of the objective kind of examination than the traditional type. But in the end a saving of time will have been realized, not to mention escape from the drudgery of trying to read and grade a set of good, bad or indifferent essays. Unquestionably, one of the most important requirements of a good examination is objectivity. That is, the nearer the examination comes to eliminating personal judgment in the scoring and grading of the answers the better it is. Indifferently constructed examinations are quite as bad as

anything else carelessly done, and what is worse, discourage accuracy and sustained effort on the part of the pupils. A completely objective examination is increasingly reliable because of reduced variability in the answers acceptable as well as in standardization of scoring and grading. Limited study and trial will convince most teachers that the subject can be handled in an objective examination and if additional time and thought are necessary to construct the newer examination, compensation will be found in the fact that the task has been elevated to the point where it challenges the teacher's more intimate knowledge of the subject matter and his interest in good teaching. Composing a good, well balanced objective examination is certainly a constructive type of labor when compared with the reading of a "set of exam. papers." Grading a lot of examinations of the newer type is rather interesting work and takes very little time. The scoring can be delegated to student assistants or clerks. It is necessary to typewrite, mimeograph or print the forms used in the objective examinations. Generally speaking, this is simply another indication of the fact that the horse and buggy age is mostly behind us.

Examples of Objective Tests with Notes.

Some sort of classification and naming of the different mechanical forms of objective examinations in use is desirable. In lieu of better knowledge of the subject the following classification of Ruch is presented with some modifications.

I. Recall Types:
- (a) Simple recall questions.
- (b) Labeling exercise.
- (c) Completion exercises.

II. Recognition Types:
- (a) Choice of word or answer exercise.
- (b) True-false exercise.
- (c) Matching exercise.

At this point the task immediately before us is that of illustrating and examining in detail the structure of several of the most adaptable forms available for use in an objective examination. This it is hoped will aid in an understanding of how a teacher can build one of the newer examinations. The newer objective exmaination is fully as applicable as the traditional examination, and, it will bear repeating, we have found the former to fit perfectly our teaching needs, as well as the subject matter of botany. After having studied the several forms presented below, comment on construction of the examination will be more easily followed and intelligent choice of the forms to be employed

can be made with facility. The examples given are merely pages from some of our examinations, selected more or less at random, but primarily with the idea of providing illustrative material. Only small portions of any one examination have been used in the illustrative material presented and none has been standardized or tested further than in our own classes. Undoubtedly those experienced in constructing and handling objective examinations will find it possible to criticize the general worth of the composition, as well as the items. In our experience, however, tests constructed along the lines suggested by the examples presented have been found satisfactory and the writer doubts the advisability of postponing the use of similar tests until the teacher has been able to completely standardize them.

Pages from Objective Examinations in Botany.

Department of Botany, University of Tennessee.

Illustration 1.

A True-False Test.

Directions: The items in this test are either true or false, if true mark +, if false mark 0. Place marks on the dotted lines at the right opposite the item number.

1. The wall of a simple plant cell is composed chiefly of cellulose. 1
2. The slimy, semi-liquid, formless substance within the cell wall is the nucleus. 2
3. Chloroplasts are non-living particles of nuclear material embedded in the sap-cavity. 3
4. The sap-cavity or central vacuole was secreted by the cell wall. 4
5. Most cells possess a single nucleus and this structure is rather dense and more coarsely granular in appearance than the cytoplasm. 5
6. The typical nucleolus occurs within the nuclear membrane and is usually quite prominent. 6
7. Intercellular spaces are spaces between cells. 7
8. The protoplast composes the "living parts" of the cell and consists mainly of the nucleus, the cytoplasm and the plastids. 8
9. Root hairs are modified xylem cells which extend into the soil. 9
10. The chief foods of the plant are the same as those of animals. 10

Notes: The true-false test is one of the easiest to construct. If wide usage is a criterion, it is a very popular and useful type of objective examination. At the present time a majority of standardized examinations of this sort include a section of true-false items. There is plenty of evidence that true-false items presented in the above form, can be answered more rapidly than the other types. According to the recent investigations of Ruch, however, the true-false type is slightly less reliable

than either the multiple-choice, or the recall type of test. True-false items such as given in the example are entirely objective.

As to the psychological soundness of presenting false statements in an examination there seems to be a slight difference of opinion among expert pedagogues. Reliable authorities, however, express the opinion that any such unsoundness of this type of test is not a proved fact and we may further note its continued wide use.

ILLUSTRATION 1a.

Comparison of Gametophytes and Sporophytes.

Directions: Mark + in proper square if true; 0 if not true.

		A Liverwort (Marchantia)	A Fern (Polypodium)	Selaginella	Pine	Trillium
GAMETOPHYTES	Chlorophyll present					
	Stomata					
	Archogonia					
	Separate male & female gametophytes					
	Male gamete free-swimming					
SPOROPHYTES	Sporogenous tissue predominates					
	Absorbs from soil					
	Homosporous					
	Embryo rests					
	Tendency toward seed habit, or seeds					

Notes: This adaptation of a tabular comparison chart for use in an examination has proven very satisfactory. It makes possible a comprehensive review without burdening the student or the instructor, and moreover satisfies the requirement of a good objective test.

ILLUSTRATION 2.

Recall type—Labeling exercise.

Directions: Name the parts of a typical plant cell: write the correct name or answer on the blank line at right of arrow.

Diagram of a typical *Elodea* leaf cell.

Notes: This is a recall type of test which might be classified as a completion test. Often we entitle this kind:

labeling test. Figuring of structures, and objects of all sorts and of all dimensions can be used to excellent advantage in objective examinations in Botany. The labeling test may be made use of where it is desirable to measure the student's knowledge of certain structures.

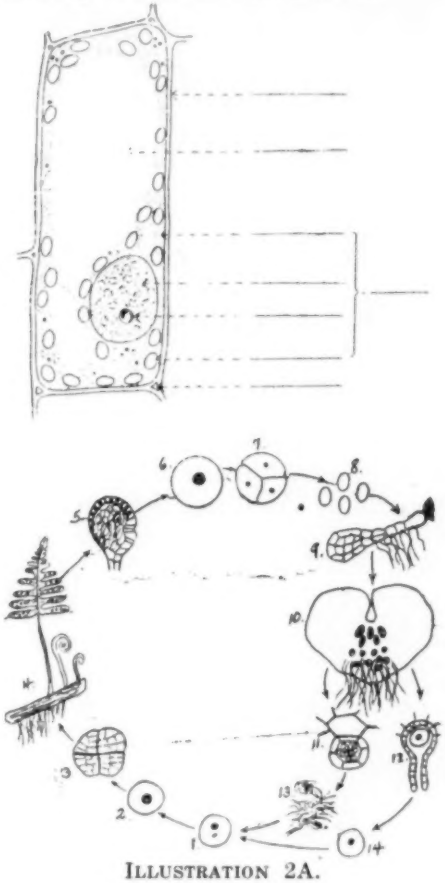


ILLUSTRATION 2A.

Name each structure by number as indicated:

1.	8. .....
2.	9. .....
3.	10. .....
4.	11. .....
5.	12. .....
6.	13. .....
7.	14. .....

N. B. Draw a line separating, and label to indicate the two generations.

Note: A very useful exercise of proven worth.

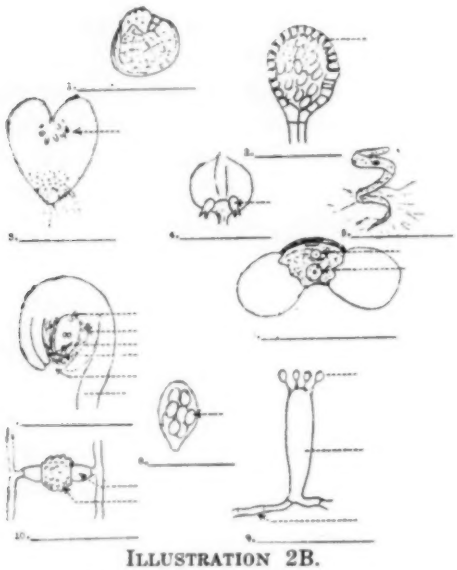


ILLUSTRATION 2B.

Test 2—Labeling—Give name of plant in each case. Give title of each figure. Label details indicated by dotted line.

Note: Imagine the task examining a large class for equivalent details, using the essay type of test.

ILLUSTRATION 3.

Completion Test.

Directions: Complete the statements in this test by writing a suitable word on each of the dotted lines.

1. The wall of the simple plant cell is composed largely of —. 1
2. The slimy, granular, more or less liquid type of protoplasm found within the wall is the —. 2
3. Another type of protoplasm is represented by the plastids and these when possessed of chlorophyll are called —. 3
4. As a general thing a single more or less spherical — occurs embedded in the cytoplasm. 4
5. A — is clearly differentiated within the nucleus of some plant cells. 5
6. Collectively the cytoplasm, nucleus, plastids constitute the bulk of the —. 6
7. A relatively large — filled with cell sap and other substances occupies considerable of the available space within the cell. 7

Notes: The completion test may be found to lack complete objectivity unless special pains are taken in its construction.

Another way of handling the completion exercise is to compose a paragraph covering the subjects. Then as many key words are omitted from the text of it as may be desired. For example:

Robert Hooke was the first to see that plants were composed of———— ————————. Cells of the *Elodea* leaf are separated by transparent————————————walls which are composed chiefly of a

substance known as———————————. In the average cell, numerous conspicuous green spherical to ovoid ——————— occur floating in a slightly granular semi-liquid substance known as ———————————. Probably the next most conspicuous cell structure is the ———————————, which is present in every cell. Protoplasm is an inclusive term—etc.

Note: This type of completion test offers slightly greater mechanical difficulty in the checking and scoring, but can be made as good an objective test as any.

ILLUSTRATION 4.

Recognition Type—Multiple-Choice Test.

Directions: Study each of the items below with the idea of determining the best answer. Record your choice by writing its number on the dotted line at the right and opposite its proper item number.

1. The scientist who discovered that plants were composed of cells was (1) Boyle (2) Edison (3) Henry (4) Hooke (5) Pasteur. 1
2. The unit structure of plants is called the (1) cell (2) cytoplasm (3) chloroplast (4) nucleus (5) vacuole. 2
3. The most conspicuous part of the *Elodea* leaf cell is the (1) vacuole (2) plasma membrane (3) chloroplast (4) nucleus (5) cytoplasm. 3
4. The plant cell is a structure having (1) one (2) two (3) three (4) four (5) five dimensions. 4
5. Movement within the cell is due to motion of the (1) chloroplasts (2) cytoplasm (3) sap (4) vacuoles (5) nucleus. 5
6. The most significant thing about protoplasm is its power to (1) absorb (2) secrete (3) excrete (4) change (5) reproduce itself. 6
7. Mendel is chiefly noted for his studies in (1) plant physiology (2) vaccination (3) plant classification (4) fermentation (5) heredity. 7

This type of test appears to be one of the most satisfactory. In the first place any word or idea that can be made the subject of a sentence can be used essentially as illustrated in the items in the examples given. It appears from a comparison of scores made by our own students that this type of test is easier for the average individual to handle. From extensive studies of types of examinations Ruch (3) concludes that multiple-choice recognition examinations are easier than the recall types in the sense that higher average scores are earned.

ILLUSTRATION 5.

Matching Test.

Directions: Each of the statements in the column on the right is essentially a question and the answer for each is *one* of the items in the left hand column. Find the correct answer for each question and place its number on the line at the left of the question.

1. Robert Hook	.....Established the germ-theory of disease
2. Schleiden & Schwann	.....Unit characters in heredity.
3. Darwin	.....An early Greek botanist.
4. Pasteur	.....Discovered that plants are composed of cells.
5. Theophrastus	.....The cell theory.
6. Linneus	.....The survival of the fittest.
7. Mendel	.....Binomial nomenclature.
8. Asa Gray	

The matching test is well adapted to examining the students' knowledge of outstanding workers and their contributions, authors and their writings, and especially historical characters and events. This type of test will however, be found adaptable to other uses.

ILLUSTRATION 6.

Best-Answer Test.

Directions: Study each item then indicate your choice as to which of the answers given is the best one. Write its number (only) on the proper dotted line at the left.

1. The best one of the following definitions of osmosis is:
   (1) The absorption of water by root hairs.
   (2) Diffusion of the particles of a substance through suitable membranes.
   (3) A form of diffusion that results in pressure. 1
2. Which of the following best defines photosynthesis?
   (1) Light synthesis and food manufacture in green plants.
   (2) A building up process in which carbon dioxide and water are combined to form a carbohydrate only in the presence of chlorophyll and radient energy.
   (3) The process whereby certain raw materials from the soil are first decomposed then synthesized by the plant, the final result being carbohydrates and other foods. 2
3. Practically no carbon dioxide is set free from living chlorenchyma on a bright day because:
   (1) The sun is shining.
   (2) The plant is transpiring vigorously.
   (3) The carbon dioxide is being used in the process of photosynthesis.
   (4) The plants are respiring. 3
4. Transpiration of water takes place directly from:
   (1) The stomata.
   (2) The guard cells.
   (3) The epidermis of the leaf.
   (4) The moist surfaces of mesophyll cells. 4
5. Morphologically the sweet potato should be classified as:
   (1) A root adapted for storage.
   (2) A modified underground stem.
   (3) A bulb. 5
6. Structures are said to be homologous when they are:
   (1) Alike in size.
   (2) Similar in appearance.
   (3) Morphologically alike, i.e., have identical structural origin.
   (4) Similar and perform the same functions. 6

Notes: The examples included pretty well illustrate the usefulness of this type of test. It is comparable with the multiple-

choice test as a recognition test. Recognition of proper concepts, definitions and the like can be handled very nicely in the best-answer test.

(To be continued)

HELIGOLAND NOW BIRD REFUGE.

Concentration of bird airways during the spring and fall migration season has turned the island of Heligoland, before the war Germany's strongest fortification, into an important ornithological station.

On the higher part of the island is located a bird house and a small fenced-in area which is planted with bushes, trees and undergrowth. As this spot has practically the only verdure found on the rocky island the migrating birds are attracted to it and caught by means of two large weirs which are located here and effectually hidden by the undergrowth. Food and decoy birds help attract the migrants. Some of the rarer species are kept in the bird house for the purpose of observation or exhibition.

From time to time during migration an aeroplane has been used to observe the flights, and, in order to facilitate the recovery of small banded birds, the station has for some time followed the practise of coloring the feathers of these captives with a green, red or blue preparation. This experiment has been successful as many such colored individuals have been recaptured.

The majority of migrating birds pass over the island at night, and as many as 20 or 30 kinds have been frequently noted. On one occasion the director noted 50 kinds in one night. These birds concentrate on the lighthouse on dark nights. Attracted by the brilliant light, they circle around it and settle upon the ground to rest, when they can be captured.

In order to prevent birds from being stunned or killed by dashing against the light a system of external reflectors has been placed on the lighthouse tower, so that most of the birds detect it in time and avoid the danger.

Since May 30, 1909, the bird protection law of the Reich has been in force on the island; by it a number of specified birds were protected, but only during specified months. Since April, 1926, the provision of the Prussian bird protection law have been made applicable to Heligoland. A number of birds are protected all the year round and many more during the breeding season.—*Science News-Letter.*

DID YOU KNOW THAT:

The moon is slowly receding from the earth?

Synthetic rubies made in the United States are shipped to Germany for cutting?

The average school teacher doubles his salary after about thirty-four years of teaching?

The shape of a negro's nose unfits him for living in a cold climate?

There is no enamel on the back surface of a beaver's teeth thus causing them to wear more on the back surface than on the front, making them self-sharpening?

Only flat hair is curly?

The sun is visible after it is really below the horizon?

Raindrops never fall faster than about twenty-five feet per second?

THE UNIT METHOD OF INSTRUCTION AS APPLIED TO THE TEACHING OF PHYSICS.

By R. S. Howard,

Lyons Township High School, La Grange, Ill.

The field of pedagogy is filled with the more or less abandoned remains of systems for teaching subjects but there are, among them, but few for teaching pupils; subject matter has been the chief concern. Teaching has been considered well or poorly done depending upon how much of the subject matter was retained long enough to be given back to the teacher in the recitation.

It is of common knowledge to teachers of science that many of their pupils come to them poorly equipped with the tools for learning, pupils unable to get from the printed page ideas there presented; pupils unable to perform the simplest processes in mathematics or to reason clearly from cause to effect even in the most simple and obvious cases. The subjects they have taken have failed to leave a lasting impression, have failed to equip the boy or girl with the tool or a real desire for learning. We know also that the Universities make similar comment about the products of our science courses. This state of affairs is certainly not all attributable to the inability of the boys and girls to learn what we seek to teach them but what is more probable it is the result of partly teaching the subject matter we attempt to cover. It is the result of measuring education in terms of pages covered, instead of a real attitude of learning brought about in the pupil.

The unit method of instruction has as its aim the changing of the learning attitude of the pupil and the subject matter is the agency for producing this change. This does not mean that the subject matter is slighted in the process of bringing about the right attitude, but rather that it is given more consideration in order that the subject be capable of producing a fundamental change in the student. Results are not measured in ground covered but rather in the development of the individual towards a condition of intellectual independence. The results of education have certainly shown that the efficiency of teaching cannot be measured alone by the extent of the subject matter passed over.

We will trace briefly the procedure used in the development of a unit of study. The selection of the unit is of vital importance. It must contain something to understand, something that can

be made a part of the individual, something that is fundamental to the understanding of much assimilative material. Around this nucleus the student should be able to collect from various sources, such as reading, demonstrations, and laboratory work, a mass of information that will give him a real understanding of the basic conception embodied in the unit, and, in turn, this understanding should be capable of making possible the real assimilation of facts connected with it. This central theme, when properly understood, should be capable of changing the attitude toward environment, should become a part of the pupil and be the means of opening up new interests after he has left the course in Physics. Tyndall did for science what the basic idea of a unit should do for the student.

This selection is not as simple as it may seem, and in fact units will change as the teacher learns from experience. What seemed a logical unit at the beginning will often be found to be but a part of a more fundamental conception. Physics lends itself well to the unitary method and in fact we have been using units in the teaching of physics for years (mechanics, heat, light' sound, electricity), yet it is doubtful, even with the obvious natural divisions of the subject, if many teachers would select an identical list of physics units or would agree upon their sequence. Selection of the units is a matter of growth. Following is a list of the units we are using at the present time.

THE UNITS OF PHYSICS FOR THE YEAR.

1. Pressure below the Surface of Fluids.
2. Force and Motion.
3. Work, Power and Mechanical Energy.
4. Heat Energy, a Form of Motion.
5. Magnetism—Electricity—their Production and Effects.
   a. When electricity is not produced by induction.
   b. When electricity is produced by induction.
6. The Production and Properties of Sound.
7. The Nature and Uses of Light.
8. Invisible Radiations.

The development of the unit as given by Prof. H. C. Morrison follows in the sequence of exploration, presentation, assimilation, organization, recitation. This general order has been followed in our use of the unitary method with modifications as to the manner of handling the work within these divisions and with the addition of the examination.

Before passing to a consideration of the steps in the teaching process it will be well to consider the condition at the beginning of a school year. Our pupils come to us presumably equipped with

enough understanding of the principles of elementary mathematics to be able to apply them to the physical relations they will encounter during the physics course. They have been using books as their sources of information for years and it is natural to suppose that the physics text will supply them with the information we propose that they shall get. Resting on these assumptions and planning the work accordingly will lead to most unsatisfactory results if the assumptions are untrue for a large majority of the class. Our experienee has proved to us that the assumptions are false in a large proportion of the cases and we do not believe that our pupils are any less well prepared in their mathematics and reading ability than pupils from other high schools. It is well known that transfer between subjects is slight unless a conscious effort is made to point out the application of the things before to the new situations the pupil meets. Without knowledge on the part of the teacher of the deficiencies in the tools of learning which the pupil brings to the new work much wasted effort is sure to follow and the apparent inability of pupils "to get" physics may not be the physics at all but simply an inability to express and use relationships that would be apparent if the mind could focus upon them rather than be engaged in the effort of unraveling the symbols that stand for the physical conceptions. And again if a pupil is dependent upon the written page for new information and he has never learned to do more than read words, then the ideas that lie back of the words will forever be a mystery to him. The reaction is the common one, "I cannot understand physics."

What are we to do in the face of such a situation? We cannot send them back to be taught again, we have them for better or for worse. The only course that seems possible is to find the deficient ones and teach them that which they need to know and above all to show them the real cause of their trouble. With this object in view the first few days of the school year are devoted to testing, in order to find those pupils deficient in reading ability and the elementary mathematical adaptation. A typewritten resume of the mathematics used in physics is given each pupil. This includes arithmetic, algebra, plane and solid geometry. Time is given them to look this over carefully and a test is given covering the principles involved. From this test the pupils who will need assistance are determined. The scope of the mathematics is small and is but a minor part of that covered in their previous training. A reading test is next administered and the word pro-

nouncers, and the slow and rapid readers are identified.

If the results of these tests are simply recorded little benefit to the pupil would come from them but if the results are used as a means of correcting deficiencies by direct teaching and acquainting the pupil with the causes of difficulty to understand physics they can be made into instruments of great value.

A short course in the use of logarithms is given next and continued until most of the class can make use of this great time-saver. There are always those who have difficulty in the use of logarithms and acquire the ability only after long training.

We are now ready for a consideration of the first unit.

The Exploration.

The function of the exploration period is to find what is already known about the subject matter that is to be studied. Here the teacher determines what background the class brings with it for an understanding of the unit. The pupils will realize that there is something to learn. The exploration questions may be written or oral. Our experience has shown the oral method to be the better since it is possible to increase the range of topics beyond that of a written test.

Let us consider from the unit, "Pressure Below the Surface of Fluids," a few examples as an illustration of the exploration period. We shall find how definite already are the ideas of measurement, pressure, force, area, density, volume, the compressibility of liquids and gases, what causes the mercury to rise in a barometer, if air has weight, if any have heard of Pascal, Archimedes, Boyle or Torricelli and if they know of their scientific work. The basis of the unit has been sounded. We shall probably learn that there is little real understanding of the points touched upon. This should also be evident to the class. A knowledge of ignorance should be a motivation for study. He that knows that he knows not and knows what he can learn is in a fair way to lend himself to learning. The results of this exploration will determine to some extent the content of the presentation that is to follow.

Presentation.

If a motive for learning has been established the time to utilize it is at once. The class begins to read. They have been supplied with references. This reading period continues for two or three days, for a background must be built up in preparation for the presentation. The outline of the unit, which the presen-

tation will give, would fail to register without this preparation. When the preparation is considered completed, the presentation is given by the teacher.

The presentation is the guide for the study of the unit. It is a bird's eye view, broad in its scope but yet specific enough to form an outline that will be useful as a guide for study. It may be read but it is much more impressive if it is given orally. The time consumed by the presentation should be as short as possible and still allow it to be complete. Too much detail will spoil the incentive for reading later, and will confuse, instead of clarify, the subject. We have found it advisable to include some lecture table demonstrations.

The presentation is the opportunity to focalize the study during the assimilation, upon the essentials of the unit. The class knows that it will be required to write an outline covering the presentation. This makes an incentive for close attention and develops the ability to learn from oral teaching. The results of the test will reveal whether the class has caught the ideas intended to be conveyed, not the details but the basic ideas that will be the guides in acquiring a grasp of the unit. If the presentation did not "go over" it must be given again and tested as before. Rarely does a presentation require more than two trials. The errors of the first are checked by the results of the test. Here is an opportunity for using the scientific method in teaching, that is, experiment and the careful recording of the results. A presentation can be worked out from experience and recorded in the form of a new presentation to be preserved for the following year.

There will be a few pupils who will probably not react to even a second presentation and they will be noted for more individual instruction during the assimilative study. When the unit is sufficiently well understood the assimilative period begins.

Assimilation.

Before considering this period in detail it is necessary that we first discuss the viewpoint of the teacher. It must be kept in mind that teaching the principles of physics is not the only objective. Other objectives are, the development in the pupil of correct study habits; the teaching of the interest habit; the development of the ability to read comprehensively; training in the use of mathematical symbols. The attainment of these objectives requires individual as well as collective teaching. The assimilative period gives the opportunity for this work. We must realize

the necessity for this type of teaching otherwise it will be neglected.

The pupils should be made to understand that want of interest comes from a lack of knowledge and that interest will grow apace with progress in understanding. This idea can be made a source of study motivation. If an understanding of the unit has been attained the collection of assimilative material bearing upon it becomes a pleasure.

The reading and laboratory work is kept focused upon the underlying principles. When we spoke of an understanding of the unit having been attained it referred to a different degree of understanding than will be developed later through the assimilative reading and laboratory exericises. We may understand a principle and yet it may not be understood in such a way as to be usable or be the agency for the acquisition of new understandings. Real knowledge becomes firmly fixed within us by use. The reading and laboratory period of assimilation is intended to serve the purpose of fixing permanently that which was but meagerly understood at the beginning of this study.

We make use of five texts, six copies of each, and other books taken from the school library. These constitute the study room library. We have collected a large supply of articles taken from the daily papers and from scientific magazines. This material is placed in letter folders and is accessible during the study period. Pupils bring to the room outside articles that they have found and these are added to the collection.

Reading should have a definite aim. In order to direct it, a list of questions and problems is given each pupil at the beginning of the assimilative period. These questions and problems form another guide to the reading and laboratory exercises. The problems are solved and handed in. They are inspected and when wrong are returned to the pupil for correction. This process continues until each problem has been solved correctly. The manner of handling records will be considered later.

It is hardly necessary to mention the advantage of bringing different viewpoints to bear upon the same subject. The interest and backgrounds of pupils vary and a text that appeals to one may not appeal to another. If the selection of reference books is made large there is a greater chance of bringing to the pupil that which will satisfy him than there is when he has but a single text as his only source of reading.

From time to time, when necessary, the class is brought to-

gether for table demonstration. Discussions are encouraged and new demonstrations are suggested as a result of the discussions. These are given later or if possible at this class period. When a number of pupils are having the same difficulties they are separated from the class for conference. Their troubles are overcome by the method that seems best fitted to accomplish the purpose, it may be by reading some text with them and explaining the meaning, or by pointing out the connection between the points in question and other parts of the unit that are already understood by the pupils. There is no necessity for involving those members of the class who already have an understanding of the subject matter that is under discussion.

The question arises, when should laboratory experiments be introduced. It seems clear to us that they should not be introduced until the ground is prepared and an adequate appreciation is had of what the experiments are to illustrate, and until a reason arises for performing them. Laboratory work can accomplish much or can easily be so much time wasted. All of us who have used the prepared laboratory manuals have had the experience of questions such as: What goes here? do we subtract this number from this? what do we find that for? These questions, of course, indicate a lack of appreciation of the significance of the experiment, and even if the experiment is carried through and correct numerical results are obtained, we are not sure, often, that the act of performing it has accomplished its purposes. For example, the simple experiment of the pendulum can be performed and yet the laws of the pendulum remain just so many words.

Consider the procedure that brings the pendulum to the demonstration table. As it swings back and forth the class discuss what can be found out about it. When they consider the pendulum from that standpoint, it is not difficult for them to arrive at the factors that will effect its time of swing. If they understand the terms, amplitude and period, which may be new in their vocabulary, they can make up their own data sheet to be used later in the laboratory and it will not be necessary then to answer such questions as are often asked when the prepared data sheet is used. When the pendulum experiment begins, they will have in their minds a definite goal. The discovery method is here just as it would be if the pupil were turned loose to find for himself the laws of the pendulum but the difference lies in the fact that he now has something to discover. He has a real motive.

He does not flounder about finding something to find. This could be called the directed discovery method of laboratory work. At the high school level pupils have not yet reached the goal of complete self dependence in study but are only on the way to it and need to be carefully directed.

The same principles of teaching that apply to this case just cited apply equally well to any lecture demonstration. The purpose of the experiment must first be clearly understood otherwise it is just something else happening. The fact that science is built upon experiment should be so deeply ingrained in the pupil by the time he has finished the physics course that it will be his first consideration when contemplating any natural phenomena in the future.

The time to terminate the assimilation period is determined by conferences with individual pupils and by the results of oral and written teaching tests. When this type of study is concluded the organization period begins.

Organization.

The pupil makes use of the written outline as the means of organizing the subject matter around the nucleus of the unit. The outline is usually prepared without the help of books but there are some individuals who are benefited more by using books for this purpose in the early units until they have developed the ability to organize their knowledge. The organization of the subject matter goes far in giving a clear understanding of its proper relations both to the unit in hand and to units that have gone before. It is here, when they attempt to correlate, that pupils often find for the first time the clear relations between the associated subject matter and the principles of the unit. Two periods is the maximum of time allowed for the preparation of the outline. These are read by the teacher and those not well done are returned for correction and rewriting. This work is completed outside of class time. The recitations begin at the next class period.

Recitation.

Not more than six pupils are selected for recitation. Some days before the recitation the students are notified they are to give a talk before the class on assigned parts of the unit. As an example of these assignments let us consider the unit, "Force and Motion." The topics used are as follows: "Measurement and Representation of Forces;" "Newton's Laws of Motion;" "The

Pendulum;" "Molecular Forces;" "Uniformly Accelerated Motion:" Pupils may use notes or demonstration apparatus in presenting their topics. After each recitation, time is allowed for questions and discussion by the class.

When the recitation phase of the study is reached the class has developed an understanding and a background that makes a recitation interesting to all the class. There is now a fund of information from which the pupil can draw, he is critical of what he hears. When recitation is attempted with the pupil able to give out very little because he has little to give, the process becomes either a skipping about from one to another until one is found who is able to recite or else an attempt, by leading questions, to draw out enough to pass for a recitation.

During the recitation and discussion period the teacher should be in the background, since the class has enough momentum to run itself. One is often surprised to find pupils, who usually have little to say, entering into the discussion of some topic upon which their opinion is different from that of the pupil before the class.

For the first few units it is necessary to caution the speakers against addressing their remarks to the teacher and to make it clear to them that their primary purpose is to convince the class of the soundness of their logic and the truth of their statements.

A recitation carried out in the manner outlined serves the dual function of teaching the class and teaching the pupil how to teach. He soon recognizes the fact that he must be well prepared before he feels sure of himself and is able to make a creditable recitation. After the conclusion of the recitations comes the examination.

Examination.

We are cognizant of the trend, in certain quarters, away from the written examination. We believe, however, that the examination serves a useful purpose. It offers an incentive, a complete substitute for which we have failed to find. The need for answering questions that require thought is a valuable developer of the power of concentration and the motive for holding the mind to the work is clear and evident.

We make use of three kinds of examinations. The ordinary problem and question type, the completion type and the true-false type. All examinations are mimeographed, numbered and are kept in letter folders in a filing cabinet.

When giving the examination, two sets of questions are used for

each class, for obvious reasons. Those papers receiving a grade of less than 85 are considered below passing. This mark is purely arbitrary and the examinations are made to fit the arbitrary standard. Here again it is necessary to use the experimental method and to remake examinations, in the light of experience, until the examinations test what we propose they shall test, and the results of the examinations show that the student has really acquired the adaptations embodied in the unit. The papers of those receiving a grade of 85 or better are returned to the student at once and must be corrected by him and returned before final credit is given for them. Those below 85 are retained but must be corrected during the hour after school. One hour each week is reserved for this purpose. Before a correction is attempted at least a half hour study is required. If the paper is then correct it is accepted and the pupil is eligible for a new examination. If it is found to be incorrect the same procedure is repeated the following week and this process continues until the paper is entirely complete.

The opportunity for removing conditions on the units is given on another after school period each week. These examinations are given in rotation, as for example, number one is given the first week after completion of the first unit and is repeated each week until the second unit is finished. The second unit then takes its place and the first and second alternate until the third unit is ready and so on. The reason for requiring that the paper be corrected in the class room is to insure more study on the unit material before a new examination is attempted. If the extra effort were left to the discretion of the pupil there is doubt whether it would be done by those most in need of it. Under this system the "just get by" attitude is made of no avail. The pupil knows there is a requirement that must be met, that there is no escape from it and that it requires effort on his part to meet it.

The correction of written work, by the pupil, not only embraces the examination papers but includes problems and laboratory experiments. Before the work is considered complete any written work, everything attempted, must be done completely and thoroughly.

To require this of pupils requires a great deal of clerical work, more than any one person can possibly do. The student assistant is the solution.

For large classes two will be necessary. This method of taking

care of the detail work is satisfactory from the standpoiut of the department and the benefit derived by the pupils who undertake this work makes the extra effort worth while for them. To describe, in detail: the duties of the student assistants would require much more space than is allotted to this paper.

The records we keep are called, "Deficiency Lists," "Make up Examination Lists," "Experiment Lists," "Daily Problem Lists," and "Recitation Records." The manner of making these accomplishment files would also require too much space to describe and but one point will be touched upon. The basis of them is a mimeographed list of each class roll made at the beginning of the school year. These sheets are of great value in reducing the time necessary for making the various records.

The unit method of teaching physics is not a panacea for every difficulty met in education, but we believe it is a step in the right direction, however. The pupil himself becomes the major consideration. The teacher finds a new incentive in his teaching for there is more constructive thinking required than is necessary when the usual text-book recitation procedure is followed. Units can be bettered, new assimilative material can be introduced and the results of laboratory work in its relation to the unit, studied. Teaching becomes the work of the truly professional teacher and teaching is raised out of the narrow limits of the text-book, the question and the answer.

STANDARDIZED TESTS IN SEVENTH AND EIGHTH GRADE SCIENCE.

By Herbert J. Stack,

Supervisor of Secondary Schools, Johnstown, Pa.

The general tendencies in our Junior High Schools in teaching science in grades seven and eight in addition to the regular ninth science has brought up the question of just what should be taught in these grades.

In most school systems if we consider as 100 the number of pupils in grade seven, only 80 get into grade nine, and perhaps 20 may finish High School. This means that the science of grades seven and eight may be the last science that pupils may study while in our schools.

The material of the seventh and eighth grades must be organized then around the natural interests of the pupil, the understanding of the common science of the environment and science that will be functional in the life of the pupils.

The following tests have been designed to fit a need of an achievement test to measure the work of our Junior High School pupils. These tests have been built up as a result of experimental work with various types of objective questions.

The tentative norms that have been established up to the present time are as follows:

Science of Health—Grade 8—40.1

Community Science—Grade 8—42-7

The time required for each test is 35 minutes.

SCIENCE ACHIEVEMENT TEST.

Grade 8B—The Community and Our Living Surroundings.

SECTION A.

Multiple Choice—Complete Each Statement by Underlining the Correct Part.

1. A good sportsman is one who always *gets the bag limit, shoots the straightest, takes advantage of every loophole in the law, obeys the fish and game laws.*

2. An animal considered as vermin is *a protected animal, a fur-bearing animal, a native animal, a destructive animal.*

3. Habitat refers to *what an animal does, what an animal looks like, where an animal lives, what the animal's habits are.*

4. Our State owes the variety of weather it gets to *the trade winds, the Weather Bureau at Washington, the Prevailing Westerlies, the location on the Atlantic Coast.*

5. The cooling effect when a person perspiring freely is exposed to a draft is due to *evaporation, poor circulation, overheating, exhaustion, cold air.*

6. A rising barometer indicates the approach of *cloudy weather, approaching storm, heavy rainfall, clear weather, rain.*

7. The branch of natural science that treats of the study of weather is *biology, chemistry, botany, meterology, entomology.*

8. The reason why hot air rises in a pipe is because *hot air contracts, it tries to get away from the heat, it occupies less space, it expands.*

9. The change from water vapor to liquid is called *condensation, evaporation, contraction, distillation.*

10. An undesirable street tree under most conditions is the *Norway maple, poplar, tulip tree, ash, oak.*

11. One of the most famous naturalists and bird lovers was *Thomas Edison, Audubon, Charles Darwin, Benjamin Franklin.*

12. One of the most common faults of gardeners in this vicinity is *they plant too early, their gardens are too small, they do not have sufficient tools, they do not select the right seeds.*

13. In case of finding that the soil in my garden was very acid, I would apply *fertilizer, bone meal, manure, lime, phosphate.*

14. An organization active in protecting the forests in our state is *The Shade Tree Commission, The City Government, The Boy Scouts of America, State Educational Association.*

15. One of the most difficult fish to keep in our aquaria is the *catfish, bass, sunfish, trout, perch.*

16. If I were building a new lawn around my house I would enrich the present soil by the use of *lime, potash, fresh loam, charcoal, coal ashes, sawdust.*

17. Chlorine is often used in our water *to make it pure, to kill algae and bacteria, to make it fresh, to make it clear.*

18. The worst enemy of our song birds is *the sparrow hawk, the stray cat, the weasel, the snake.*

19. In repotting ferns and other house plants a little of one of the following mixed with the soil will give the best results *lime, ground bone, leaf mold, nitrate of soda, ashes.*

20. The best way to propogate most house plants is by the use of *seeds, roots, cuttings, graftings.*

21. Indicate what you, as a good citizen, would first do if accidentally your campfire got away from you into neighboring leaves *get out of the way before the fire warden catches you, try to put the fire out, go and telephone the fire department, let it go and keep away from the smoke.*

22. Our State abounds in wild game at the present time, largely because *we always had good hunting, we have state forests,*

we do not allow hunting, we have protective game laws of various kinds, there are not as many hunters as in other states.

23. Our weather maps are made up at weather bureaus *by consulting almanacs, from newspaper reports, from reports of radio stations, from telegraphic reports from other weather bureaus.*

24. A rapidly falling barometer indicates *fair weather, snow, a sudden storm, calm weather.*

25. The instrument used by aviators to determine their altitudes is called a *wind gauge, thermometer, hydrometer, aneroid barometer, mercury barometer, hygrometer.*

Total Possible Score 25. Score.....

SECTION B.

Completion—Will you indicate in the blank space provided for the correct answer?

26. In our state we protect our game by the use of (a).....

.....

27. The female member of the bee family is called the (b).....
.....while the male is called the (c).....

28. The trees that shed their leaves in the winter are called (d).....while those that retain their leaves are called (e).....

29. Insects are most harmful because they (f).....
while a few such as the (g).....are beneficial.

30. The clothes moth may be prevented from injuring clothing by (h).....while the best way to fight insects that attack trees is to (i).....

31. The organization in our city that takes care of planting street trees is the (j).....

Total Possible Score 10. Actual Score.....

SECTION C.

Limited Response—Will you indicate in the space provided the best answers to the following questions?

32. Name five song birds that visit us in the spring but go south in the winter (a).....(b).....

(c)..... (d)..... (e).....
.....

33. What four game birds are used for food? (a).....
..... (b)..... (c).....
(d).....

34. What three definite things can you as a citizen do to assist in forest conservation?
(a).....
(b).....
(c).....

35. What are the four best shrubs to use for planting around your homes? (a)..... (b).....
(c)..... (d).....

36. What three definite things can you do to assist in having more street trees?
(a).....
(b).....
(c).....
Possible Score 20. Score.....

SECTION D.

Right and Wrong Impressions—One of the important purposes of science is to correct erroneous ideas. Some of the statements below are wrong ideas. Will you indicate with a cross wrong statements and with an "O. K." the correct statements?

1. On a hot summer's day a water pitcher sweats, the small drops coming through the walls of the pitcher.

2. If it is overcast in the morning and there is a heavy dew it is quite likely to clear up.

3. The male bird is more highly colored than the female.

4. Most birds migrate in the winter season.

5. All evergreen trees are called pines.

6. The English sparrow is beneficial.

7. All butterflies and moths have cocoon stages in their life history.

8. Weather Bureau reports are not reliable.

9. Rain before seven clear before eleven.

10. It always feels colder when the air is damp than at the same temperature when it is dry.

Total Possible Score 10. Score.....

HEALTH SCIENCE—ACHIEVEMENT TEST

	Possible Scores	*Actual Scores*
Scoring Multiple Choice	20	.....
Completion	25	.....
Right Statements	10	.....
Total	55	

In the following statements underline the part that will make the statement most true.

1. The best way to cultivate a good health habit is *to study about health, discuss health with your friends, practice the habits, learn some good rules of health.*

2. The most important requirement for success in life is *having a good education, being intelligent, coming from a good family, having good health.*

3. A collection of similar cells is called *an organism, a tissue, a muscle, a function, a gland.*

4. Ordinarily the best temperature of a schoolroom is *60F, 78F, 69F, 68F, 75F.*

5. The principal muscle building nutrients are the *fats, mineral matter, carbohydrates, proteins.*

6. In order to give children a sufficient amount of bone building materials their diet should include *plenty of meats, hot soups, fish, fruits and vegetable, chocolate.*

7. The salivary juice is active in digesting the *sugar, fats, starches, proteids.*

8. The most important use of the red blood corpuscles is *to protect the body against disease, give color to the blood, carry the oxygen supply.*

9. The most important aim of Health Science is *public health*

is of prime importance to the state, the spendthrift of health is the guiltiest of spendthrifts, to form good habits and physical condition, how to make a balanced menu.

10. The heart is made strong by *sitting, resting, outdoor games, studying how the heart pumps blood, taking heart medicines, vigorous exercise.*

11. The circulation of the blood was discovered by *Robert Koch, Edward Jenner, Louis Pasteur, William Harvey.*

12. The best way to develop an ability to play basketball is *to watch experts play the game, to read a guide or book on basketball, to practice playing.*

13. The seat of the sensory activities of our nervous system is *in the spinal cord, in the cerebrum, in the cerebelum. in the sympathetic nervous system.*

14. Most of the impressions on our brain we receive by *feeling things, hearing, seeing, tasting.*

15. Alcohol has what effect upon the body *increases the memory, increases the skill, lowers the memory, makes people bright, gives steady nerves.*

16. The best way to keep from catching colds is *to wear heavy clothing, to keep the body in good physical condition, to eat plenty of food, to go to a doctor when you first begin to sneeze.*

17. An anti-toxin used for diphtheria is *a vaccine, a toxin, a medicine, a product from the horse, a bacteria from cows.*

18. One of the most important values of cellulose in foods is *to build up the blood, to furnish materials for bone building, to assist food in passing through the intestines, to build up muscles.*

19. The pancreatic juice acts upon the *starches, fats, mineral matter, proteins, all the nutrients.*

20. Most of the absorption of digested food takes place in the *stomach, colon, mouth, small intestine.*

In the following statements certain important terms or parts are left out. Will you fill in the correct parts?

21. The nutrients that supply warmth and power to the body are called the..... and.....

22. The most important function of the sweat glands is to .....

23. The best thing to do with diseased adenoids or tonsils is .....

24. The organs that take proteid impurities from the blood are .....

25. Blind people are able to read by the use of .....

26. One example of a common stimulant that is very harmful is .....

27. Foreign bacteria cells that get into the body are destroyed by .....

28. Nearsightedness can usually be overcome by the use of .....

29. The telephone receiver is very similar in purpose to the human ..... while the camera most resembles the human .....

30. Artillery men in firing heavy artillery usually stand on their toes, open their mouth and cover their ears because .....

31. Indians and pioneer scouts developed a very keen sense of hearing by .....

32. In order to get a good picture of a fractured bone the ..... may be used.

33. The best advice to give a person suffering from tuberculosis is to .....

34. The best way to cultivate a good habit like cleaning one's teeth regularly is to .....

35. If a wound bleeds very freely, in all probability what has been cut? .....

36. One of the best ways of treating a nose bleed is .....

37. Vitamines are usually found in ..... kinds of foods and are usually destroyed by ..... the food.

38. The best way to relieve fatigue is to.....

39. All "catching" diseases are caused by..... which are carried in various ways.

40. In order to prevent smallpox we may be..... On the other hand after having caught diphtheria, doctors use

.....

There are certain untruths that many people believe in. Will you place a cross in front of the false statements included in the list below? To correct false ideas is one of the purposes of Health Science.

1. Don't bother about a little cold.

2. An apple a day keeps the doctor away.

3. Coffee is strong, it ought to make you stronger.

4. Don't break quarantine laws.

5. There is no use bothering about first teeth, we lose them anyway.

6. Night air is bad, keep your windows closed.

7. For stomach trouble use ———— Stomach Bitters.

8. Walking is one of the best exercises.

9. Tea and coffee are harmful.

10. One should clean his teeth at least once a day.

Total Possible Score 10.

THE JUNIOR COLLEGE MOVEMENT GROWS LARGER.

The rapid growth of the Junior College movement makes it possible in many cities for students to go to college in the public school system. Speaking before the Institute for Administrative Officers of Institutions of Higher Education at Chicago Dr. Leonard V. Koos, Professor of Secondary Education at the University of Minnesota, gave a report of a study of this movement. He said that the movement has doubled in the last five years. There are now about 100 public junior colleges, more than twice the number reported in 1922. Enrollments in these colleges have increased about two hundred percent. Private junior colleges and those on state foundations swell the number reported in the United States to well over 300, about 100 more than were in existence five years ago.—*School and Society.*

THE MATHEMATICS AND SCIENCE CURRICULA IN JUNIOR AND SENIOR HIGH SCHOOLS.

By Carter V. Good,

Miami University, Oxford, Ohio.

What objectives are emphasized in the mathematics and science work offered in the secondary schools of today? What courses in mathematics and science are provided in junior and senior high schools? To what extent are mathematics and science required of all high-school pupils? The present report attempts to present at least partial answers to the preceding questions.

This report is a part of a larger investigation which was made in order to determine the objectives, constants, and electives of the entire secondary-school curriculum. Early in 1927 letters were sent to each state department of education and to the superintendents of the five largest cities in each state requesting copies of the junior and senior high school programs of study in current use. The manuals and programs of study received as a result of this request were examined in an effort to answer the questions raised in the first paragraph of this report.

The aims of mathematics and science are tabulated separately in two lists that follow this paragraph. An effort was made to preserve the original language of the courses of study from which the aims or objectives were extracted. Such a procedure serves to preserve the original meaning and to facilitate comparisons of the terminology used in stating objectives. The aims are listed according to frequency of mention from highest to lowest. The lists of objectives for mathematics and science are as follows.

MATHEMATICS OBJECTIVES	Frequency
1. Command of fundamental operations	12
2. Appreciation of beauty in geometric forms of nature	11
3. Ability to understand and interpret graphical representation	9
4. Ideals of perfection as to logical structure	9
5. Appreciation of power of mathematics and role of mathematics in development of civilization	8
6. Become familiar with geometric forms common in nature	8
7. Acquiring mental habits making training effective in life of individual	7
8. Ability to think in terms of ideas and concepts	7
9. Get idea of habit of quantitative thinking	7
10. Ideas of relationship or dependence	7
11. Speed and accuracy	5
12. Habit of checking results	5
13. Ability to use and interpret formulas	5
14. Instruction and training in the mathematics useful to the average citizen	4
15. Means of pupil discovering valuable results for self	4
16. Understanding language of algebra	4

17. Ability to analyze and interpret results 3
18. Develop powers of understanding and analyzing relations of quantity 3
19. Ability to think and express thoughts accurately 2
20. Increased ability to understand sciences 2
21. Successful vocational activity 2
22. Teach proper attack upon recognized types of problems 2
23. Training in "functional" thinking 2
24. Ability to draw correct conclusions from given data 1
25. Create power to judge argument impartially 1
26. Citizenship 1
27. Challenge pupil's interest in solving written problems 1
28. Development of inventive faculty through use of original exercises 1
29. Discover mathematical abilities 1
30. Efficiency in computation 1
31. Logical reasoning, as exemplified in geometrical demonstration, between the true and the false 1
32. Precision of statement and of thought 1
33. Power of individual attention and prolonged concentration 1
34. Supply training which yields personal gratification 1
35. Show the economy of mathematical reasoning 1
36. Stimulate originality 1
37. Worthy home membership 1

SCIENCE OBJECTIVES	Frequency
1. To help pupil to interpret his environment	12
2. Citizenship	8
3. Supply fund of interesting information	7
4. Help pupils become better acquainted with natural science factors in environment	6
5. To encourage pupil to form accurate habits of observation and expression	6
6. To awaken science interest and ability, that scientific interests may be continued	6
7. Technique of experimentation	6
8. Train in scientific methods for problem-solving	6
9. Help pupils understand natural science phenomena and applications	5
10. To instil scientific attitudes	5
11. To reveal strictly scientific vocations	5
12. Health	4
13. To provide "hobbies" for leisure time	4
14. To give beginners a general knowledge of field	4
15. Vocational training	4
16. Worthy home membership	4
17. Ability to think clearly and accurately about scientific material	3
18. Cooperation	3
19. Inculcation of scientific spirit	3
20. Interrelation of sciences	3
21. Preparation to meet college requirements	3
22. Use of leisure time	3
23. Appreciation of natural and moral laws	2
24. Discover appreciation for domesticated varieties of experience and desire to cooperate in their improvement	2
25. Ethical character	2
26. Help pupils read intelligently the literature of current science publications	2
27. Interest in betterment of human conditions and human race	2
28. To create an interest in lives and works of great scientists of the past	2
29. To bring about an idea of the vastness and grandeur of the universe	2
30. To stimulate scientifically inclined; a desire to accomplish something worth while in scientific field	2

31.	Conservation of natural resources	1
32.	Discover aptitudes	1
33.	Develop knowledge of personal and community hygiene	1
34.	Develop logical habits of thinking	1
35.	Develop reasoning powers	1
36.	Enable student to understand scientific appliances with which he is likely to come in contact	1
37.	Formation of good habits	1
38.	Help pupils build more efficient controls of environmental factors	1
39.	Help pupils develop ability to solve natural science problems for self	1
40.	To show that science has entered all vocations	1
41.	To inspire youth with desire to rid earth of all parasitic diseases	1
42.	To see importance of natural resources	1
43.	To inspire desire to protect forests and useful foliage and plants	1
44.	To develop in child who is interested in only one science a post-school scientific interest	1
45.	To help students grasp the two fundamental factors of heredity and environment	1
46.	To develop in students a desire to protect game, and humane attitude toward living things	1
47.	To lead students to see that the laws of development are nature's creative processes	1
48.	To understand that man is subject to and a product of the laws of natural development and that man progresses toward perfection through application of nature's laws	1
49.	To train boys in the fundamentals of first aid	1
50.	To give understanding of the significance and importance of natural sciences	1

It is not to be assumed that the lists of general objectives, as tabulated for mathematics and science, are complete or are specific and detailed enough for the several subdivisions of the two large divisions of secondary subject matter. There is no evidence available in a printed program of study to show conclusively that school systems follow definitely the aims or objectives that are included. However, a summary of the objectives listed in high-school manuals and courses of study does indicate current lines of emphasis and trends in secondary-school mathematics and science. The schools included in the analysis are representative American junior and senior high schools and are distributed over a wide geographical area.

An examination of the list of objectives reveals that there is considerable duplication and overlapping of emphasis in the statements. However, as has been suggested, an effort was made to retain the original language of the programs of study. For instance, under science objectives, Nos. 13 and 22 are concerned with leisure-time values of science.

A useful analysis of the junior high school curriculum has been reported recently by Tryon, Smith, and Rood.[1] The results

[1] R. M. Tryon, H. L. Smith, and Allan F. Rood, "The Program of Studies in Seventy-Eight Junior High School Centers," *School Review*, XXXV (February, 1927), pp. 96-107.

of their analysis of mathematics and science are given in Table I. An examination of Table I indicates that mathematics is required of all pupils in the seventh grade in the seventy-eight junior high school centers studied, is required in seventy-six centers in the eighth grade, and in forty-five centers in the ninth grade. Such data show that mathematics ranks high among the constants or required subjects in the junior high school.

TABLE I—MATHEMATICS AND SCIENCE COURSES OFFERED IN SEVENTY-EIGHT JUNIOR HIGH SCHOOL CENTERS.*

Course Title	Seventh Grade		Eighth Grade		Ninth Grade	
	Constant	Variable	Constant	Variable	Constant	Variable
MATHEMATICS	78	0	76	5	45	35
Mathematics	50	0	54	3	34	13
General mathematics	3	0	5	0	2	5
Arithmetic	25	0	17	2	1	3
Elementary geometry	1	0	0	0	0	0
Algebra	0	0	2	0	19	21
Practical mathematics	0	0	0	0	0	1
SCIENCE	22	3	45	11	28	42
Science	14	0	17	3	11	4
General Science	8	1	23	7	10	29
Elementary science	0	0	5	1	0	0
Commercial science	0	0	1	0	0	0
Biology	0	0	0	0	7	6
Nature study	0	1	0	0	0	0
Physical geography	0	0	0	1	0	4
Botany	0	0	0	0	0	1

Table I shows that science is required of all pupils of the seventh grade in 22 centers, in the eighth grade in 45 centers, and in the ninth grade in 28 centers. Most of the science in the junior high school is offered under the titles of science and general science. Most of the mathematics work in junior high schools is offered under the titles of mathematics and arithmetic, with algebra turning up rather frequently in the ninth grade.

Table II presents the results of the writer's analysis of the mathematics and science curricula in thirty senior high schools located in the largest cities of various states and distributed over a wide geographical area. Although the senior high school may be thought of as including the tenth, eleventh, and twelfth

*The figures opposite the general headings or subject groups, "mathematics" and "science," do not represent totals for the subdivisions under the subject group, since a given school may offer more than one type of work under a subject group. For instance, a given school may offer more than one type of work in mathematics and therefore be represented more than once in the tabulation.

grades where the junior-senior organization is in effect, data for the ninth grade were included in Table II for purposes of com-

TABLE II—MATHEMATICS AND SCIENCE COURSES OFFERED IN THIRTY SENIOR HIGH SCHOOLS.

Course Title	Ninth Grade		Tenth Grade		Eleventh Grade		Twelfth Grade	
	Constant	Variable	Constant	Variable	Constant	Variable	Constant	Variable
MATHEMATICS	18	21	4	36	2	48	0	69
Advanced algebra	0	0	0	0	0	6	0	5
Advanced mathematics	0	0	0	0	0	0	0	1
Algebra	10	9	1	7	0	13	0	8
Arithmetic	0	4	0	1	0	0	0	2
Calculating	0	0	0	0	0	0	0	1
Elementary algebra	0	1	0	0	0	0	0	0
General mathematics	2	3	0	2	0	0	0	0
Geometry	0	0	2	10	1	11	0	5
Intermediate algebra	0	0	0	0	0	1	0	1
Mathematical review	0	0	0	0	0	0	0	2
Mathematics	6	2	1	5	0	2	0	1
Plane geometry	0	0	0	8	1	2	0	0
Plane trigonometry	0	0	0	0	0	0	0	4
Rapid calculation	0	0	0	1	0	0	0	0
Review algebra	0	0	0	0	0	1	0	1
Review geometry	0	0	0	0	0	0	0	2
Senior arithmetic	0	0	0	0	0	0	0	1
Shop mathematics	0	0	0	2	0	0	0	0
Special geometry	0	1	0	0	0	0	0	0
Solid geometry	0	0	0	0	0	11	0	14
Surveying	0	0	0	0	0	0	0	1
Trigonometry	0	0	0	0	0	1	0	20
Vocational mathematics	0	1	0	0	0	0	0	0
SCIENCE	8	22	0	44	1	57	1	58
Advanced chemistry	0	0	0	0	0	0	0	1
Agriculture	0	1	0	0	0	1	0	1
Applied chemistry (girls)	0	0	0	0	0	0	0	1
Applied science	0	0	0	0	0	0	0	1
Astronomy	0	0	0	0	0	0	0	3
Biology	2	2	0	19	0	4	0	3
Botany	0	1	0	6	0	3	0	2
Chemistry	0	0	0	2	0	23	0	17
Chemistry (girls)	0	0	0	0	0	2	0	0
Civic biology	1	0	0	0	0	0	0	0
College physics	0	0	0	0	0	0	0	1
Elementary science	0	2	0	0	0	0	0	0
Food chemistry	0	0	0	0	0	1	0	0
General science	5	13	0	2	0	0	0	0
Geology	0	0	0	0	0	0	0	2
Household chemistry	0	0	0	0	0	1	0	0
Household physics	0	0	0	1	0	1	0	0
Laboratory science	0	0	0	1	0	0	0	0
Physical geography	0	1	0	4	0	0	0	1
Physical science	0	0	0	1	0	0	0	0
Physics	0	0	0	3	0	17	0	23
Physiography	0	1	0	0	0	0	0	1
Plants and animals	0	1	0	0	0	0	0	0
Science	0	0	0	1	1	3	1	1
Zoology	0	0	0	4	0	1	0	0

parison. In Table II the figures opposite the general headings or subject groups, "mathematics" and "science," represent the totals of the subdivisions. A constant is interpreted as a subject required of all pupils, while a variable is a subject offered as an elective or not required of all pupils in the given high school.

Eighteen of the thirty senior high schools require mathematics in the ninth grade; eight schools require science of all pupils in the ninth grade. With very few exceptions mathematics and science prove to be electives or variables in the tenth, eleventh, and twelfth grades of the senior high schools represented in the analysis.

Table II shows the year in which a given subject is most frequently offered. For instance, plane geometry in the schools represented is offered as a rule in the tenth grade, solid geometry in the eleventh and twelfth grades. Chemistry is usually offered in the eleventh grade, physics in the eleventh and twelfth grades, biology in the tenth grade, and general science in the ninth grade.

Attention may be called to the relatively large number of titles under which mathematics and science work is offered in junior and senior high schools, especially in senior secondary schools. For instance, according to the writer's interpretation, work in algebra may be offered under the following titles: advanced algebra, advanced mathematics, algebra, calculating, elementary algebra, general mathematics, intermediate mathematics, mathematical review, mathematics, rapid calculation, review algebra, shop mathematics, and vocational mathematics. Certainly it seems that if there is any division of subject matter in the high school where it is possible to agree on a common body of material to be offered under a common title, it is mathematics. The writer has pointed out at other times the need for some agreement with regard to the terminology used in the course titles of the high school. It appears that not even the well-established subject of mathematics has standardized its terminology or crystallized the subject matter to be offered under a given title. Probably just at present in the field of mathematics this experimentation with new organizations of subject matter is a desirable thing. However, it does not seem desirable for this practice to continue indefinitely.

The statements made concerning mathematics in the preceding paragraph may well be applied in large part to the secondary-school work in science. The reader may select from Table II a

number of course titles that include considerable work in chemistry. As the writer has pointed out for other school subjects at other times, some agreement as to the terminology used in labeling a common body of subject matter in mathematics and science will facilitate the transfer of pupils from one school to another, simplify the task of the college officials in charge of admissions, and clarify the comments of writers and speakers who deal with curriculum problems in mathematics and science.

The data of Table II provide striking evidence of the rapid expansion of the high-school curriculum, particularly the mathematics and science curriculum, within the last decade or two.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

ANNUAL MEETING, NOV. 25 AND 26, 1927, CASS TECHNICAL HIGH SCHOOL, DETROIT, MICH.

Members of the association will find satisfactory hotel accommodations at the headquarters, Hotel Statler, and at Hotels Fuller, Fort Wayne, and Leland Detroit, all located conveniently near Cass Technical High School.

Dues should be sent to W. G. Gingery, Treasurer, Shortridge High School, Indianapolis, Indiana, and receipt will be ready at the Treasurer's and Secretary's desks in Cass High School. The Treasurer's and Secretary's desks will be found in the office of the building. Copies of the yearbook containing all details of the meetings can be secured by writing to E. R. Breslich, School of Education, University of Chicago.

General Sessions, 9:30 a. m.

Address of Welcome: Superintendent Frank Cody, Detroit.

Response: W. F. Roecker, Milwaukee, Wis.

Preliminary report of the Resolutions Committee: Charles H. Stone, University of Chicago.

The general session on Friday will be addressed by: Professors Charles H. Judd, University of Chicago (subject, "Experimental Studies on the Nature of Mathematical Thinking"); William H. Hobbs, University of Michigan (subject, "Exploring at the North Pole of the Winds").

The general session on Saturday will be addressed by: Professor W. D. McMillan, University of Chicago (subject, "The Evolution and Dissolution of Matter); Professor Henry C. Cowles, University of Chicago (subject, "Botany in Its Human Relations"); Principal E. Lewis Hayes, Detroit (subject, "Industrial Education in Detroit").

The annual dinner will be held in Hotel Statler on Friday, at 7:00 p. m. The dinner will be followed by an address by Professor Elliot R. Downing, Chicago (subject, "The Added Years").

On Friday, at 4:00 p. m., members may visit the exhibit in Room 122, attend the social hour in the gymnasium, or inspect Cass Technical High School. There will be a reception in Hotel Statler preceding the dinner.

The Executive Committee will meet on Friday at 8:00 in Cass Technical High School, and at 12:30, Saturday, at Hotel Statler.

A business meeting of the Association will be held Saturday morning at 9:00 in Cass Technical High School.

Excursions have been planned for Saturday, at 12:30. Parke, Davis & Company have invited the Association to visit their plant on Friday at 4:00 p. m. This will give the party one hour to visit some of the chief places, such as the laboratory and the rooms in which drugs are manufactured.

The section meetings are held Friday afternoon, at 1:30, as follows:

CHEMISTRY—ROOM 217.

Raymond W. Osborne, Chairman, Francis W. Parker School, Chicago, Ill.

"The Manufacture of Drugs," Dr. F. O. Taylor, Parke, Davis & Company, Detroit; "Some Aims in Elementary Chemistry," Dr. R. C. McAlpins, University of Michigan; "Helps in Teaching Industrial Chemistry," Dr. Alex C. Burr, College of the City of Detroit; "A Summary of a Five-Year Study of Certain Aspects of Learning in High School Chemistry," Earl R. Glenn, Lincoln School of Teachers College, New York; "What Constitutes Efficient Demonstration Work in Teaching Elementary Chemistry," Raymond R. Jared, Cass Technical High School, Detroit; "The "Co-öperative Method of Handling the Overload," Dr. Andrew McLeod, Crane Junior College, Chicago. General discussion. Election of officers.

GENERAL SCIENCE—ROOM 123.

Francis D. Curtis, Chairman, University of Michigan, Ann Arbor, Michigan.

"An Investigation of New Curricular Units in General Science," C. L. Thiele, Ass't. Director of Exact Sciences, Detroit Public Schools, Detroit, Michigan; "Superstition and the Teaching of Science," J. O. Frank, State Normal School, Oshkosh, Wisconsin; "Goals for Accomplishment in General Science," S. R. Powers, Teachers College, Columbia University, New York; "Supervised Study in Science," Wilbur L. Beauchamp, School of Education, University of Chicago, Chicago, Illinois; "The Contract Method of Teaching Science," Ira A. Davis, University of Wisconsin, Madison, Wisconsin. General discussion. Election of officers.

GEOGRAPHY—ROOM 205.

Vica Dutton Martin, Chairman, Arsenal Technical Schools, Indianapolis, Indiana.

"Cruises along By-Ways of the Pacific," Dr. W. H. Hobbs, University of Michigan, Ann Arbor, Michigan; "Creating Interest in the Commercial Geography Class," 20 minutes, Ona Giffin, Decatur High School, Decatur, Illinois; "An Opportunity for Student Activity in Commercial Geography as Presented in Northern High," 5 minutes, C. W. Blanchard, Northern High School, Detroit, Michigan; "The Value of the Bulletin Board in Teaching Commercial Geography," 5 minutes, Grace A. Robinson, Cass Technical High School, Detroit, Mich.; "A Project in Commercial Geography," 5 minutes. J. R. Schudler, Central High School, Detroit, Michigan. General Discussion. Election of Officers. (Note: The above are all illustrated by lantern pictures and exhibits).

MATHEMATICS—ROOM 203.

Joseph A. Nyberg, Chairman, Hyde Park High School, Chicago, Ill.

"Functional Analysis of a Unit of Work in Ninth Grade Mathematics," Charles A. Stone, University High School, Chicago, Ill.; "Adjusting the Course of Study in the Ninth Grade Mathematics to the Ability of the Pupil," Hildegarde Beck, Northwestern High School, Detroit, Mich.; "An Investigation of Achievements in Plane Geometry," Fred A. Burroughs, John Adams High School, Cleveland, Ohio. General discussion. Election of officers.

PHYSICS—ROOM 417.

M. J. W. Phillips, Chairman, High School, West Allis, Wis.

"A list of Experiments in High School Physics," E. W. Kiebler, East Lansing, Mich.; "The Common Unit of Measure Used in High School Science Text Books," Oscar Himebaugh, Akron, Ohio; "Five Years of Experimenting with Objective Tests in Physics," Ellsworth S. Obourn, John Burroughs School, St. Louis, Mo.

BIOLOGY—ROOM 209.

All meetings begin promptly.

J. R. Locke, Chairman, Highland Park High School, Detroit.

"The Para Rubber Tree in the Amazon Valley," Dr. Carl La Rue, Professor of Botany, University of Michigan, Ann Arbor, Mich. (Illustrated.)

"The Teaching of Osmosis by Biology Teachers," Dr. H. H. Bartlett, Director of Botanical Gardens and Arboretum, University of Michigan, Ann Arbor, Mich.

"The Manufacture of Biological Products," Dr. L. T. Clark, Research Department of Parke, Davis and Co., Detroit, Mich. (Illustrated by Motion Pictures).

General discussion.

HOW TO REMOVE STINGS.

When one is getting stung by a bee is not a propitious time to make accurate observations, but it is nevertheless a great help if there is a clue to the identity of the offender. Chemically the poison of a bee is just the opposite of that of a wasp and should be treated with different remedies. The bee sting is acid and should therefore have some weak alkaline preparation like the wet soap or weak ammonia recommended for mosquito bites. The wasp's sting, on the other hand, is alkaline and should be treated with applications of vinegar.

The technique of removing the sting of a bee or wasp from a wound is very important. The sting with the poison sacs that are attached to it is usually left behind by the insect as a memento of his attentions. If one follows the natural instinct and pulls the sting out with the fingers or with forceps, the poison sacs are squeezed and more poison is forced into the wound. The preferred way, the experts tell us, is to lift the sting out carefully with the blade of a knife so that the sacs are left intact.

Thousands of bees have been dissected and their poison analyzed by scientists to find out its exact composition. Formic acid is the main constituent, accompanied by minute amounts of complex organic compounds. The pure poison placed on uninjured skin, one investigator found, would produce absolutely no injurious effect. The slightest break in the surface of the skin or a needle puncture through a drop of the poison caused the typical reaction of a sting. Some people are much more susceptible to the poison of bees and wasps than others, and it is among this group that cases of collapse and death from stings occur.—*Science News Letter.*

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University, Normal, Ill.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

CORRECTIONS.

May issue, page 540, second line from top, should read "sections make a sphere."

June issue, page 646, third line below figure, "polar of P" should read "inverse of P."

SOLUTIONS OF PROBLEMS.

971. *Proposed by John Ankebrandt, Gunnison, Colorado.*

Find the smallest number which when divided by 2 has a remainder of 1, when divided by 3 has a remainder of 2, when divided by 4 has a remainder of 3, and so on, but when divided by 17 there is no remainder.

I. *Solved by Walter H. Carnahan, Indianapolis, Indiana.*

The L. C. M. of all the integers from 1 to 16 inclusive is 720,720. Therefore 720,719 is the least number which when divided by N leaves a remainder of $(N-1)$, where N is any integer from 1 to 16. If multiples of 720,720 be added to 720,719 until a number is found which is divisible by 17, the second condition will be satisfied. That is, we seek a number

$$720{,}720X + 720{,}719 = 17Y,$$

or

$$42395\frac{5}{17}X + 42395\frac{4}{17} = Y.$$

Any value of X times 5/17 and added to 4/17 will give a number satisfying the conditions. In other words

$$5/17X = R + 13/17, \text{ or } (17R+13)/5 = X,$$

for which we are to find integral solutions. It is evident that $(17R+13)$ is a multiple of 5 for all R's ending in 1 or 6. Hence R = 1 will give the smallest X and the smallest Y. When R = 1, X = 6, and the required number is 5,045,039.

II. *Solved by J. Murray Barbour, Aurora, N. Y.*

The L. C. M. of the integers (1, 2, 3 . . . . . 16) is 720,720. $720{,}720 \equiv 5 \bmod 17$. Hence $5m-1 = 17n$. $m = 7$, $n = 2$. Hence the required number is $7(720{,}720)-1 = 5{,}045{,}039$.

Also solved by *Paul A. Knedler, Cranford, New Jersey; McKendree W. Coultrap, Naperville, Ill.; E. de la Garza, Brownsville, Texas; Smith D. Turner, Cambridge, Mass.; M. Freed, Wilmington, Cal.; Michael Goldberg, Washington, D. C.; A. J. Patterson, Wheeling, W. Va. and the Proposer.*

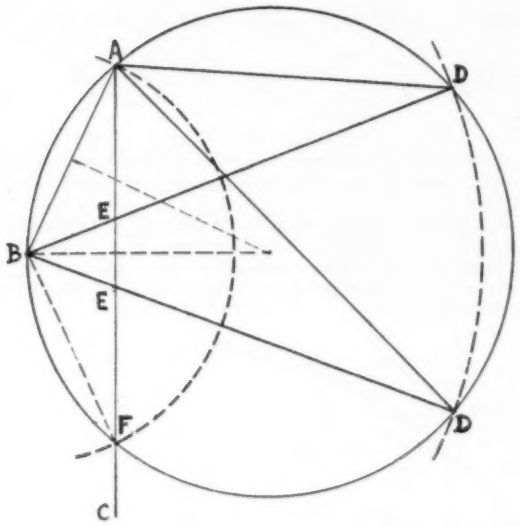
972. *Proposed by Orville F. Barcus, Columbus, Ohio.*

Given an angle BAC with given side BA, and a given line BD intersecting side CA at the point E. Determine the point E so that AD:AE = BD:AB.

Solved by George Sergent, Tampico, Mexico.

It is only necessary to construct two similar triangles having a common side, BA, and a common angle B.

Construction. On BA as a chord draw the arc containing the given angle BAC. In this arc draw from B the chord BD equal to the given length. Its intersection with AC determines E, the required point.



Since the triangles ABD and EBA are similar, AD:AE = BD:AB. The construction is possible if the arc described from B as a center and the given line, BD, as a radius, intersects the circumcircle of triangle ABF (F being the intersection of AC with the arc containing the given angle. If R is the radius, we have 2R = AB/sinBAC. Hence the test

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for construction is

$$BD \leq \frac{AB}{\sin BAC}$$

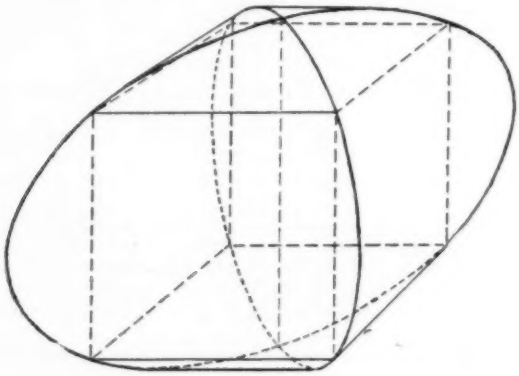
In the first case, there are two solutions, E and E', symmetric points. In the second case, there is one solution, and E is the foot of the perpendicular from B to CA.

Also solved by *R. H. Shanks, Culver Military Academy, Culver, Ind.*

973. *Proposed by Raymond Huck, Shawneetown, Ill.*

Suggested by Problem 960. Determine the edge of the maximum cube inscriptible in the common volume of the two intersecting cylinders.

Solved by the Proposer.



Consider the cube inscribed. A diagonal section of the common solid will reveal a rectangle, whose sides are as $1:\sqrt{2}$, inscribed in an ellipse of the equation

$$\frac{X^2}{2a^2} + \frac{Y^2}{a^2} = 1.$$

Also $Y:X = 1:\sqrt{2}$. Hence $2Y = a\sqrt{2}$, the required edge.

Also solved by *Michael Goldberg, Washington, D. C.;* and *George Sergent, Tampico, Mexico.*

974. *Proposed by J. F. Howard, San Antonio, Texas.*

If the points L, M, N be taken on the sides BC, CA, AB of a triangle, the circumcircles of AMN, BLN, CLM, meet in a common point.

Solved by Paul A. Knedler, Cranford, New Jersey.

Draw the circles AMN and CLM. There are three possibilities (1) they are tangent at M, (2) they intersect within the triangle, and (3) they intersect outside of the triangle.

Suppose they are tangent. Draw NM and LM. Angles AMN and CLM are right angles and therefore angles MNB and MLB are also right angles and therefore supplementary. This proves quadrilateral BLMN cyclic and therefore circle BLN passes through M.

Suppose they intersect within the triangle. Call the point of intersection O and draw ON, OM, and OL.

$\angle A + \angle NOM = 180°$ and $\angle C + \angle LOM = 180°$, therefore $\angle A + \angle C + \angle NOM + \angle LOM = 360°$.

$\angle A + \angle B + \angle C = 180°$ and $\angle NOM + \angle LOM + \angle LON = 360°$ therefore

$\angle A + \angle B + \angle C + \angle NOM + \angle LOM + \angle LON = 540°$. If we subtract the one from the other we get $\angle B + \angle LON = 180°$. This proves the quadrilateral BLON cyclic and therefore circle BLN passes through O.

Suppose they intersect outside of the triangle. Call the point of intersection O and draw ON, OM, and OL.

$\angle A = \angle NOM$ and $\angle C = \angle LOM$, they being measured by the same arcs. Therefore $\angle A + \angle C = \angle NOL$, but $\angle A + \angle B + \angle C = 180°$, therefore $\angle B + \angle NOL = 180°$. This proves the quadrilateral BLON cyclic and therefore circle BLN passes through O.

Also solved by *George Sergent, Tampico, Mexico; Michael Goldberg, Washington, D. C.*

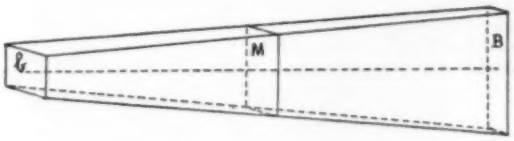
975. *For High School Pupils. Proposed by I. N. Warner, Platteville, Wis.*

How many board feet of lumber in a stick 4″ by 4″ at one end, 2″ by 12″ at the other, and 16 feet long?

Solved by George Sergent, Tampico, Mexico.

It is assumed that the bases are rectangular and parallel, and that the length, 16 feet, is their perpendicular distance.

Let B be the larger base, 2″ by 12″, b the smaller base, 4″ by 4″, and M the section determined by a plane parallel to the bases and equidistant from them. M is a rectangle 3″ by 8″.



The volume of the solid is expressed by the formula

$$V = \frac{h}{6}(B + b + 4M).$$

B = 1/6 sq. ft.; b = 1/9 sq. ft.; M = 1/6 sq. ft. Applying the for-

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mula the volume is 68/27 cu. ft. Multiplying by 12 we get the required answer, 30 2/9 board feet.

An excellent detailed solution was sent in by *Carlton Jencks, Lewis and Clark H. S., Spokane, Wash.*

Editor. In the teaching of methods to find the volumes of solids it is very helpful to use the Prismatoid Formula.

PROBLEMS FOR SOLUTION.

986. *Proposed by George Sergent, Tampico, Mexico.*

Given a frustum of a right circular cone, the radii of the bases being a and b, and the altitude h. On the line joining the centers of the bases, a point is taken as the vertex of two cones whose bases are, respectively, the bases of the frustum, and such that their lateral surfaces are equivalent. Determine the position of the common vertex.

987. *Proposed by E. de la Garza, Brownsville, Texas.*

In a given circle, with compasses only, construct the side of a regular inscribed decagon.

988. *Proposed by Arnold Lebow, Brooklyn, N. Y.*

Solve geometrically the following system of equations.

$$x^2+y^2-mxy = a^2$$
$$x^2+y^2-nxz = b^2$$
$$x^2+y^2-pyz = c^2.$$

989. *Proposed by Orville F. Barcus, Columbus, Ohio.*

Show that the Pell equation

$$y^2+(2^n+1)y+2^{2n-3} = x^2$$

is satisfied by integral values $y = 2^{2n-3}$, $x = 2^{n-1}(2^{n-2}+1)$.

990. *Proposed by the Editor. For High School Students.*

A rectangular field is 15 rods longer than wide, and has an area of 8 7/16 acres. Find the length and width. Do not use algebra.

SCIENCE QUESTIONS.

CONDUCTED BY FRANKLIN T. JONES.

The Equitable Life Assurance Society of the U. S., Cleveland, Ohio.

Please address all communications to Franklin T. Jones, 10109 Wilbur Ave., S. E., Cleveland, Ohio.

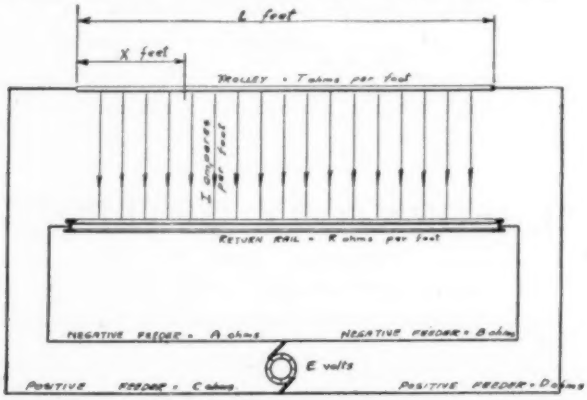
YOUR QUESTIONS WILL BE PUBLISHED.

In the October number an experienced teacher told about the reluctance of teachers to volunteer answers to everyday questions that come up.

Propose your questions in this section of SCHOOL SCIENCE AND MATHEMATICS and we will try to obtain answers for you. Just say you want your name withheld and it will be done.

QUESTIONS AND PROBLEMS.

498. *Proposed by Nat Dolwin, 111 Floyd St., New York City.*


L feet
X feet
TROLLEY = T ohms per foot
I amperes per foot
RETURN RAIL = R ohms per foot
NEGATIVE FEEDER = A ohms
NEGATIVE FEEDER = B ohms
E volts
POSITIVE FEEDER = C ohms
POSITIVE FEEDER = D ohms

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The diagram shows a section of a trolley car system.

This section which is of length "L" is fed by a generator supplying "E" volts. The positive feeders to the ends of the section have total resistances of respectively "C" and "D" ohms, and the negative return feeders have resistances respectively of "A" and "B" ohms. The current taken by the trolley cars is assumed as a uniform drain of "I" amperes per foot of line for the whole section. The trolley line has a resistance of "T" ohms per foot and the return rail (assuming only one is used as a return) has a resistance of "R" ohms per foot.

What is the voltage between the trolley and rail at any point "X" feet from one end of the section?

From Examination for Admission to Teachers College of the City of Boston, June 10, 1927.

499. *Proposed by J. C. Packard.*

(10 points) At 8 cents per kilowatt hour what does it cost to use an electric flatiron for 3 hours if the iron has a resistance of 20 ohms?

(No volts given. Why or why not? How would you answer if you found such a problem on an examination paper?—Editor.)

ANSWERS.

487. *Proposed by B. G. Spracklin, Baron Byng High School, Montreal, Quebec.*

Supposing the specific gravity of copper is 8.8, a solid piece would, of course, sink in water, but, by making a hollow ball of the right size, one could get it to float just as an ordinary tin pan floats on water. If the ball were made of 3 cu. in. of copper, how large would it need be to in order that it might float, and how large that it might float half out of water?

Solution by R. T. McGregor, Elk Grove, Calif.

(a) In order that the hollow copper ball may just float, it must displace $8.8 \times 3 = 26.4$ cu. in. of water, its own volume; and since the volume of a sphere equals $\frac{\pi}{6}$ times the cube of the diameter, the diameter of the ball $= \sqrt[3]{26.4 \div \frac{\pi}{6}} = 3.69$ in.

(b) To float half out of water, the volume of the ball must be double the volume of the one in (a), and its diameter is $\sqrt[3]{52.8 \div \frac{\pi}{6}} = 4.65$ in.

489. *Proposed by J. C. Packard, Brookline, Mass.*

Why do laths "show through" as dark stains on old plaster ceilings?

Answer by Wallace C. Swank, Eaton Rapids, Mich.

Answering Problem 489. Why do the laths "show through" as dark stains on an old plaster ceiling, I would state that the laths do not show through as dark stains. It is between the laths that is dark. The explanation is that the plaster being somewhat porous acts as a fllter to filter out any dirt that might be in the air as the air passes through the plaster. Where the plaster is backed up with the lath the air is not free to go through, hence the plaster there does not make so large a collection of dirt.

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Answer two questions from each group and four additional questions which may be selected from any of the groups. Number each answer to correspond with the question selected.

GROUP I.

1. Describe the structure of the vascular bundle of a leaf or stem, using a labeled diagram to illustrate your description.

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2. Make a fully labeled drawing of the internal organs of the frog or some other vertebrate.
3. Describe the mechanism in the ear of man which serves for the maintenance of equilibrium (i. e., balancing).
4. Compare the structure of the respiratory organs in (*a*) earthworm, (*b*) insect, and (*c*) frog (both tadpole and adult).
5. (*a*) Give distinguishing structural differences between artery, capillary, and vein.
   (*b*) Name three important changes in the composition of the blood which take place in different parts of the body.

GROUP II.

6. (*a*) Show clearly why a plant which has been defoliated (i. e., leaves destroyed) by insects is likely to die.
   (*b*) Why are leaves of plants essential for animal existence even though many animals do not eat them?
7. (*a*) Distinguish between pollination and fertilization in some plant.
   (*b*) Describe fully each of these processes, using labeled drawings to illustrate your statements where possible.
8. (*a*) What do you understand by the process of osmosis or diffusion?
   (*b*) Name three illustrations of this process in plants or animals.
   (*c*) Discuss briefly the importance of each to the plant or animal concerned.
9. Give the life-history of the common house fly.
10. (*a*) Why is nitrogen necessary for all living organisms?
    (*b*) How is it obtained in a form suitable for use by plant or animal tissues?

GROUP III.

11. Interpret the statement "Animal life is dependent upon the bacteria."
12. (*a*) What are the possible detrimental results of introducing an animal or a plant into a new region in order to reduce the numbers of some organism which has become a pest?
    (*b*) Give an example.
13. (*a*) Name two animals and two plants that are in danger of becoming extinct or that have actually become extinct recently.
    (*b*) What preservative measures should be taken in the case of those endangered?
14. (*a*) Name two diseases of plants. State in each case (*b*) the cause of the disease; (*c*) the character of the injury; (*d*) the remedy.
15. Discuss the practical application of Mendel's Law of Heredity.

ARTICLES IN CURRENT PERIODICALS.

American Mathematical Monthly, August-September, Menasha, Wis., $5.00 a year, 60 cents a copy. On the Upper Limit to the Real Roots of an Algebraic Equation by Glenn James, University of California at Los Angeles. The Greek Idea of Proportion by George W. Evans. On a set of Problems Related to the Problem of Apollonius by P. H. Daus, University of California at Los Angeles. The Analytic Determination of the Area of a Triangle in Terms of its Sides, by K. P. Williams, Indiana University.

Condor, September-October, Bi-Monthly, Cooper Ornithological Club, Berkeley, Calif., $3.00 a year, 50 cents a copy. Contribution to the Life History of the Alaska Willow Ptarmigan by Joseph Dixon, Musuem of Vertebrate Zoology, University of Calif., Berkeley. Old Times with the Birds: Autobiographical by Charles Haskins Townsend, The New York Aquarium, New York City. Strange Feature in Bird Habits by Frank A. Leach, Diablo, Calif. The Bird Life of San Ignacio and Pond Lagoons on the Western Coast of Lower California by Laurence M. Huey, San Diego, Calif.

Education, September, The Palmer Co., Boston, $4.00 a year, 40 cents a copy. Measurement and Analyses of Student Achievement in a Beginning Course in Educational Psychology by Winona M. Perry, Lincoln, Ne-

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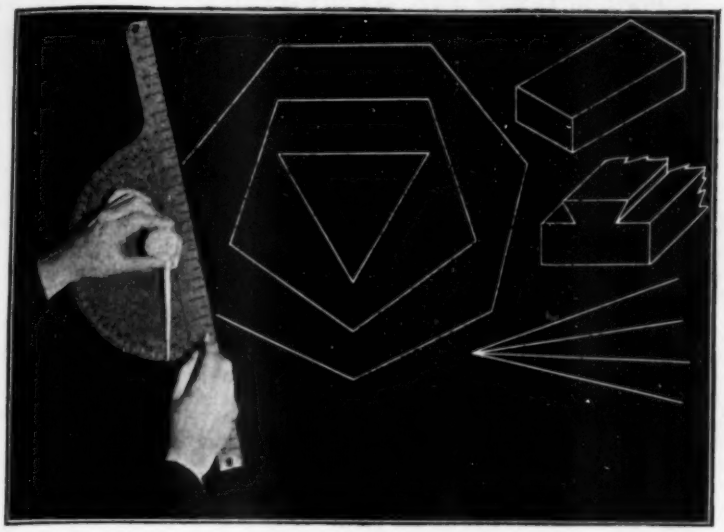

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Journal of Chemical Education, September, Rochester, N. Y., $2.00 a year, 35 cents a copy. Electricity and Matter by William S. Johnson, General Electric Company, Schenectady, N. Y. Progress of Chemistry in the First Quarter of the 20th Century by S. C. Lind, University of Minnesota, Minneapolis, Minn. Kunckel and the Early History of Phosphorus by Tenney L. Davis, Massachusetts Institute of Technology, Cambridge, Mass.

Journal of Geography, September, A. J. Nystrom and Company, 2249 Calumet Ave., Chicago, $2.50 a year, 35 cents a copy. Geography in the Junior High School. Report of the National Council Committee on High School Geography. A Survey of the Silk Industry by Harriet C. Lasier, Central High School, Washington, D. C. The School Neighborhood by Ella Huntting, State Normal School, Upper Montclair, New Jersey. Geography Lessons as Friends for Leisure by Walter Lefferts, William B. Hanna School, Philadelphia, Penn.

National Geographic Magazine, October, Washington, D. C., $3.50 a year, 50 cents a copy. By Coolie and Caravan Across Central Asia by William J. Morden. Sicily: Island of Vivid Beauty and Crumbling Glory by Luigi Pellareno. How Latin America Looks from the Air by Major Herbert A. Dargue.

Photo-Era Magazine, September, Wolfeboro, New Hampshire, $2.50 year, 25 cents a copy. Photography in School and College by Arthur L. Marble. Facts About Deeks Color-Sheets by H. G. J. Deeks. A Lens-Shade and an Exposure-Meter by Harold Locke.

Popular Astronomy, August-September, Northfield, Minnesota, $4.00 a year, 45 cents a copy. Photographing Jupiter by Latimer J. Wilson, 1405 Gartland Ave., Nashville, Tenn. Recent Advancement in Astronomical Theory by J. D. Boon, Southern Methodist University, Dallas, Texas. Isaac Newton and His Work in Astronomy and Optics by Ralph H. Curtiss. Two New Pieces of Demonstration Apparatus for Teachers of Astronomy by H. T. Stetson, Student's Astronomical Laboratory, Harvard University. A Turret Reflector by Percival R. Allen, 131 Rowe St., Auburndale, Mass.

School Review, September, The University of Chicago Press, $2.50 a year, 30 cents a copy. Accrediting of Secondary Schools in the Middle States and Maryland by E. D. Grizzell, University of Pennsylvania. Titles of Curriculums Offered or Suggested in Secondary School by Carter V. Good, Miami University, and Raymond E. Good, Dayton High School, Dayton, Virginia. The Value of Certain Home-Economics Courses as a Means of General Education by Agnes Fay Morgan, University of California.

Science, September 23, Grand Central Terminal, New York City, $6.00 a year, 15 cents a copy. Lister as Physiologist by John Tait, McGill University, Montreal. Channels, Valleys and Intermont Detrital Plains by W. M. Davis, Harvard University.

Scientific American, October, New York, $4.00 a year, 35 cents a copy. Mikimoto and the Culture Pearl by Prof. David Starr Jordan, Stanford University, California. On the Trail of the Molecule—I by S. R. Williams, Ph.D., Professor of Physics, Amherst College. Four Sunless Worlds by Henry Norris Russell, Ph.D., Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Cold Light by Dr. W. W. Coblentz, Physicist, United States Bureau of Standards.

Scientific Monthly, October, The Science Press, New York, $5.00 a year, 50 cents a copy. The Quantitative Phases of Human Geography by Professor Ellsworth Huntington, Yale University. Deserts and Semi-Deserts by Dr. Charles W. Townsend, Ipswich, Massachusetts. Two Noted Mineral Collections by Dr. George P. Merrill, U. S. National Museum. Links with Asia before the Mountains brought Aridity to the Western United

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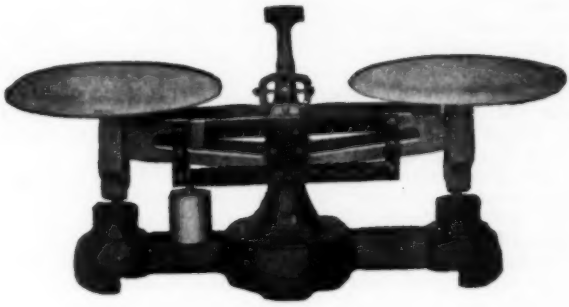

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States by Professor Edward W. Berry, The John Hopkins University. Climatic Features of Yellowstone National Park by Edgar H. Fletcher, Weather Bureau Office, Yellowstone Park, Wyo. The Sun's Heat by F. E. Fowle, Astrophysical Observatory, Smithsonian Institution.

Torreya, July-August, 8 West King St., Lancaster, Pa., $1.00 a year, 30 cents a copy. Native Orchards in and Near New York by H. M. Denslow, Chelsea Square, New York City. Concerning some Species of Machaeranthera by Geo. E. Osterhout, Windor, Col. The Frankeniaceae as a Link in the Classification of Dicotyledons by Alfred Gunderson, Brooklyn Botanic Gardens, Brooklyn, N. Y.

BOOKS RECEIVED.

Analytic Geometry by Thomas E. Mason, Professor of Mathematics, Purdue University, and Clifton T. Hazard, Associate Professor of Mathematics, Purdue University, with the Editorial Cooperation of Robert D. Carmichael, Professor of Mathematics, University of Illinois. Cloth. Pages xi+224. 20x13.5 cm. 1927. Ginn and Company, Price $2.40.

Four-Place Mathematical Tables with forced Decimals compiled by F. S. Carey, M. A., Professor Emeritus in the University of Liverpool, and S. F. Grace, M. Sc., Lecturer in the University of Liverpool. Paper. 39 pages. 22x14 cm. 1927. Longmans, Green & Company, 55 Fifth Avenue, New York. Price .40.

Elements of Mechanics by Henry A. Erikson, Ph.D., Professor of Physics, University of Minnesota. First Edition. Cloth. Pages xvi+150. 20.5x14 cm. 1927. McGraw-Hill Book Company, Inc., New York, 370 Seventh Avenue. Price $1.75.

The Buckingham-Osburn Searchlight Arithmetics, Book Four by B. R. Buckingham, Director of the Bureau of Educational Research, Ohio State University, and W. J. Osburn, Director of Educational Measurements, State Department of Public Instruction, Madison, Wisconsin. Cloth. Pages xii+390. 19x13 cm. 1927. Ginn and Company.

The Laws of Living Things by Edward J. Menge, Ph.D., Sc. D., Director of the Department of Animal Biology, Marquette University. Cloth. 530 pages. 19.5x13.5 cm. 1927. The Bruce Publishing Company, Milwaukee, Wisconsin. Price $1.72.

The Origin of Species by Charles Darwin with an Introduction by Edmund B. Wilson, Da Costa Professor of Zoology in Columbia University. Cloth. Pages xxxv+557. 18x11.5 cm. 1927. The Macmillan Company, New York.

Laboratory Experiments in Practical Chemistry by Newton Henry Black, Assistant Professor of Education, Harvard University. Cloth. Pages ix+188. 18x12 cm. 1927. The Macmillan Company, New York.

The New Mathematics, Book Three by John C. Stone, State Normal School, Montclair, New Jersey. Cloth. x+348. 18.5x12.5 cm. 1927. Benj. H. Sanborn & Company, New York. Price $1.20.

Mathematics in Secondary Education, Part I. A Report by the National Committee on Mathematical Requirements under the Auspices of the Mathematical Association of America, Inc. Cloth. Pages x+180. 17.5x11.5 cm. 1927. Houghton Mifflin Company, New York. Price $1.20.

Seashore Animals of the Pacific Coast by Myrtle Elizabeth Johnson, Ph.D., Professor of Zoology, San Diego State College, California and Harry James Snook, M. S., Head of Biology Department, Stockton High School, California. Cloth. Pages xiv+659. 23.5x15 cm. 1927. The Macmillan Company, New York. Price $7.50.

Laboratory Manual for Elementary Botany by Edmund W. Sinnott, Professor of Botany, Connecticut Agricultural College. First Edition. Cloth. Pages ix+106. 23x14.5 cm. 1927. McGraw-Hill Book Company, Inc., New York. Price $1.00.

The Calculus by Robert D. Carmichael, Professor of Mathematics, University of Illinois, and James H. Weaver, Professor of Mathematics, Ohio State University. Cloth. Pages xiv+345. 20.5x13.5 cm. 1927. Ginn and Company. Price $2.80.

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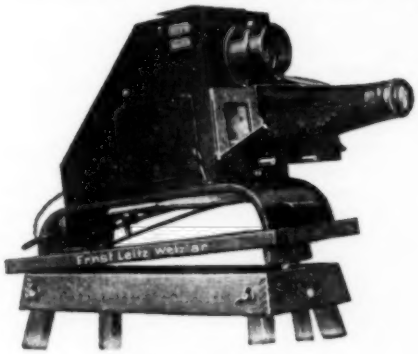

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Oxford Review Series. Paper. 19x12 cm. Oxford Book Company, New York. Chemistry by J. Ellis Stannard, A.B., Pd.B., Boys' High School, Brooklyn, N. Y. iii+251 pages. Plane Geometry by George F. Wilder, M.A., Erasmus Hall High School, Brooklyn, N. Y. vi+149 pages. Biology by M. M. Mandl, M.A., Evander Childs High School, New York City. 227 pages. Intermediate Algebra by Elmer Schuyler, M.S., Bay Ridge High School, Brooklyn, N. Y. viii+132 pages. Elementary Algebra by Elmer Schuyler, M.S., Bay Ridge High School, Brooklyn, N. Y. ix+103 pages.

BOOK REVIEWS.

Problems in Classroom Method, a Manual of Case Analysis for High School Supervisors and Teachers in Service, by Douglas Waples, Assistant Professor of Education, The University of Chicago. Cloth. Pages xxii+609. 13x20 cm. 1927. The Macmillan Company.

The author states that his volume "undertakes to propose the typical problems of classroom teaching, the principles which may be used to solve them, and the technique which teachers may follow in working out the specific solutions for specific problems met in practice." As the book concerns itself not so much with what the teacher *knows* about classroom problems as with what he *does* about them, the author lays stress on the necessity of making direct study of such problems. To illustrate the necessity of analyzing classroom problems into specific difficulties that will require separate attention before a practicable solution can be reached, a typical problem in a large city school is worked out in detail.

The book is divided into two, not independent but closely related, parts. Part I deals with some 40 case problems, each of which involves one or more specific difficulties. Solutons for each of these cases as proposed by teachers in service are criticized with the view of indicating the method that may be used by any teacher in working out solutions for problems arising in any school, class or subject. Part II contains a classified list of 424 typical difficulties that may be met by the high school classroom teacher. These specific problems are followed by solutions suggested by teachers in service, teachers in training, or selected from professional literature. It is the hope of the author that this material may be helpful to the teacher in working out the solution for such specific difficulties into which a classroom situation has been analyzed by procedures described in Part I.

Although classroom teachers have been exhorted by educationists for the past two decades to "study" their problems, this is the first book that attempts to give the teacher aid of a specific type that bear directly on classroom difficulties. Here is a book that should be of much service to the beginning teacher and to the experienced teacher. To the latter, if the outlined method of analysis is applied, unsuspected problems will be disclosed, for which solutions are suggested in Part II. R. B. Z.

Light by Vivian T. Saunders, M. A., Assistant Master at Uppingham School. Cloth. Pages vii+320. 18.5x12 cm. 1927. London, John Murray, Albermarle Street, W.

The author says: "This book is written in the hope that it may be read by students who are following an elementary but formal course in light." It is well organized for this purpose and brief enough to be covered in the ordinary course. Each new principle is illustrated by a number of applications, and sufficient historical material has been included to maintain interest and to show the development of such topics as the wave and corpuscular theories, and the evidence that investigations in light have contributed to the modern theories of the structure of matter. In addition to its use as a classroom text the book will be found valuable on the reference shelves of all high school and college libraries. G. W. W.

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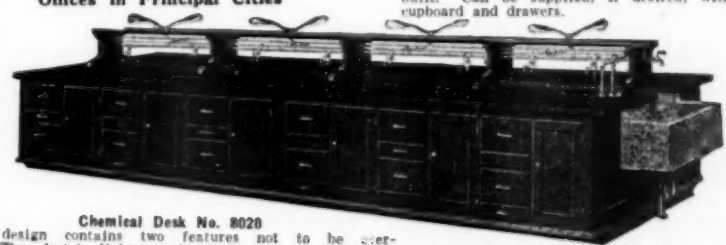

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Laboratory Exercises for a Brief Course in Chemistry, by Lyman C. Newell, Professor of Chemistry, Boston, University. Pages XII+152. 20x13x1.5 cm. Line drawings. Cloth binding of loose leaf note book with attached metal rings on metal back. 1927. $1.00. Extra sheets per packet, $0.36. Bound in cloth (not interleaved), $0.88. D. C. Heath & Co.

This new laboratory manual for elementary chemistry has two groups of experiments, a minimum course and a supplementary one. The minimum course, the reviewer is glad to note, takes cognizance of the minimum outline of laboratory requirements suggested by the Committee on Chemical Education of the American Chemical Society. The supplemental list contains: (1) Experiments intended as substitutes for some of those in the mimimum list. (2) Those that are desirable for a longer course. (3) Exercises for pupils who have extra laboratory time or who have finished the required experiments. And (4) Demonstration experiments for the teacher to perform.

The omission of questions is a striking feature In its place the author inserts precise directions for observing essential results at the proper places. Specific directions for recording notes are given at the end of each exercise.

There are 62 regular exercises and 62 supplementary ones. F. B. W.

Practical Chemistry, Fundamental Facts and Applications to Modern Life, by Newton Henry Black, Assistant Professor of Education, Harvard University, formerly Science Master, Roxbury Latin School, and James Bryant Conant, Associate Professor of Chemistry, Harvard University. Revised edition. Pages X+522. 19x13x2.5 cm. Many drawings and illustrations. Cloth. 1927. Macmillan.

While the order of treatment of subjects in this revision shows no strikingly new arrangement, beginning as it does with Chemical Changes and continuing with Elements and Compounds, Oxygen, Hydrogen, Water, etc., yet we find, in later parts of the text, some quite new and very interesting material, especially that which brings to the beginner the modern notion of subatomic structure and its manifestations in chemistry. Valence is first taught in the old way and later the valence relations in polar compounds are explained on the basis of the number of electrons in the outer orbits. The Mosely Law is well used in connection with atomic number and the new Periodic Law, X-rays and crystal structure are briefly treated. Electrolysis in relation to ions is also well handled.

The standard parts of the book are of course of excellent character and we dwell on these new departures because elementary chemistry teachers must soon be using this new material quite universally and such teachers should see this new revision. F. B. W.

Mathematisch-Naturwissenschaftlich-Technische Bücherei, Herausgegeben von Dr. Phil. Ewald Wasserloos, Oberstudiendirektor in Essen, und Dr. Phil. Georg Wolff, Studiendirektor in Hannover. Otto Salle Verlag, Berlin W 57, Elssholzstr. 15.

Band 1, Archimedes von Dr. Phil. Fritz Kliem and Dr. Phil. Georg Wolff. 142 pages.

Band 2, Fixsternboebachtungen von Professor Dr. J. Plassmann. 120 pages.

Band 3, Rechnen und Algebra von Dr. Heinrich Wieleitner. 75 pages.

Band 6, Nomographie von H. Schwerdt. 122 pages.

Among the many interesting books received during the past summer is a series of small German books for elementary students of Mathematics and Science. They include a variety of subjects, are bound in attractive covers, are well illustrated. The four volumes of this series mentioned above are now ready. These books will be of value not only in the schools and among the people of Germany, but they will also be useful as supplementary readers for German classes in other countries, especially for those students who are primarily interested in learning to read scientific German. G. W. W.

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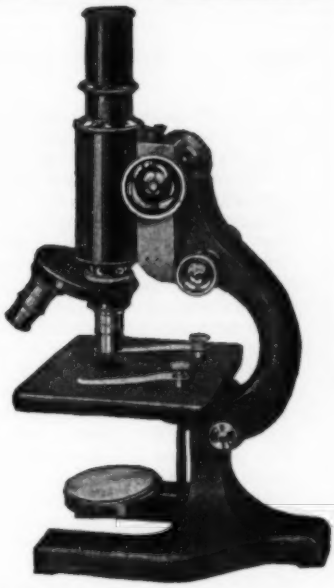

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FOR TEXTBOOKS

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General Physics by Henry Crew, Ph.D., Fayerweather Professor of Physics in Northwestern University. Fourth Edition. Cloth. Pages xi+674. 21.5x14 cm. The Macmillan Company, New York.

All college instructors and students of general physics will be pleased with this revision of a text which has been a favorite for a score of years. The author has retained his aim of presenting the subject in such a way that "the student will realize that there is a logical sequence running through the subject of general physics and will feel, long before the end of the year, that there is more fun in understanding the discussion than in memorizing it." Due recognition is given the fact that few college freshmen have a working knowledge of the elementary principles of physics around which the high school course is built. These basic ideas are fully discussed and also stated in formulae. The exercises contain many of the same types of problems and some of the same degree of difficulty as are found in the texts for secondary schools, thus giving opportunity for study assignments over a considerable range of difficulty. The exercises are numbered consecutively throughout the book and in some cases the answers to numerical problems are given.

In this edition the new physics is interwoven with the classical principles thus giving the student a unity of view rather than the idea that the new discoveries and theories have consigned the old principles to the junk heap—a notion so often acquired when the recent developments of the subject are treated in isolated chapters or a separate section of the book.

The mechanical structure of the book is excellent. A judicious use of bold faced type and italics and many good diagrams make the book attractive. An annotated reference list at the end of each chapter provides for selective outside reading for pleasure and profit. But overtopping these many good features, which are attributes of numerous similar texts, is the author's skill in saying things in understandable language. G. W. W.

Elements of Mechanics by Henry A. Erikson, Ph.D., Professor of Physics, University of Minnesota. First Edition. Cloth. Pages xvi+150. 20.5 x14 cm. 1927. McGraw-Hill Book Company, Inc., New York, 370 Seventh Avenue. Price $1.75.

This is one of a series of five volumes used in the course in General Physics at the University of Minnesota. Each of the five books covers the subject matter of a one-quarter course. The general plan is to introduce each new topic with a definition or statement of a physical principle which is fully discussed and explained, and then expressed analytically. Following the theoretical treatment one or more illustrative problems are stated, diagramed and solved, thus giving the student practice in following a line of reasoning before he starts out alone on the problems appended for solution. At the end of the book are three additional lists of problems divided according to chapters, thus giving a very convenient means of making similar but different assignments to four sections, or to one section at four different times as needed for mastery. The appendix contains a complete set of the necessary tables of constants, logarithms and trigonometric functions. The course pre-supposes a knowledge of trigonometry. The book is made brief by the elimination of historical material and discussions of applications of the topics treated. Teachers and students who see this text will look forward to the appearance of the companion volumes now in preparation. G. W. W.

Machine Shop Practice by Harry A. Jones, Machine Shop Instructor, Technical School, Vancouver, B. C. Cloth. Pages v+172. 23x15 cm. 1926. Thomas Nelson & Sons, Limited, New York.

This book is a beginner's manual in machine shop work. It is arranged on the unit plan, each lesson having a definite aim which is complete in itself but also prepares the student for the next step. In general the left hand page is used for descriptions, explanations and directions while the opposite page contains an elaborate set of diagrams which show the student how each tool and instrument is used. Each major section is followed by several pages of projects and a list of questions. G. W. W.

Advanced Constructive Geometry by J. F. Dowsett, Lecturer and Chief Instructor in Geometry and Graphics, London County Council School of Building, Brixton. Cloth. Pages viii+340. 22x13 cm. 1927. Oxford University Press, American Branch, New York. Price $9.00.

This book, written for advanced students and teachers of the building trades requiring a knowledge of descriptive or building geometry is new, and greatly different from other texts on the same subject.

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The book is neat, well bound, of convenient size, indexed with a supplement of miscellaneous practical problems. The book should be in the hands of descriptive geometry students, teachers of the subject and persons interested in the building trades. B. W. T.

The New Algebra, by H. E. Slaught, University of Chicago, and N. J. Lennes, University of Montana. Pages vii+302. 14x19.5 cm. 1926. Allyn and Bacon, Boston.

This book by these well known authors is not a revision of their Elementary Algebra. It is a new book designed to meet the requirements of the modern progressive high school. The following features should be noted:

1. Letters to represent numbers are introduced by means of formulas. The formula is used consistently throughout the text as the connecting link between arithmetic and algebra and to develop the ability in the pupil to understand its use in books of elementary science and popular journals.
2. Fundamental principles are developed by an appeal to the intuition of the pupil and one at a time.
3. At the beginning of each chapter the attention of the pupil is directed to the thing that has just been accomplished and its bearing on what is to follow.
4. The equation is emphasized not only as such but because of its use in solving problems.
5. There are three levels of problems. This fact is not pointed out to the pupil. However, the teacher by the use of the authors' manual may determine the level of each problem.
6. In the chapter on Graphical Representation the formula graph is emphasized in order to develop the notion of dependence of one variable upon another.
7. Cumulative reviews are found at the close of each chapter. These have been prepared to secure the proper scale of diminishing repetition.

J. M. Kinney.

Junior High School Mathematics, by Harry C. Barber, assisted by Helen M. Connelly and Elsie V. Karlson. Pages: Book I, xi+231; Book II, xiv+267. 14x19.5 cm. 1927. Price: Book I, $0.92; Book II, $1.00. Boston: Houghton Mifflin Co.

In 1925, one of the authors, Mr. Barber, published the Everyday Algebra which constitutes the third book of this Junior High School series. This book was reviewed in this Journal. The reviewer pointed out that it was one of the outstanding exponents of the new spirit in the teaching of secondary mathematics. The present volumes are of like character. Among the many features of these texts the following indicate their progressive nature.

1. The formula and equation are used to a large extent thus making it possible to eliminate the treatment of numerous "cases." Thus, by the use of the fundamental percentage formula, $p=rb$, the pupil needs merely to recognize the quantities p, r and b in his problem, substitute the values of the two given in the formula, and solve the resulting equation.
2. Much attention is given to constructive and mensurational geometry, scale drawings, and graphs.

3. Much textual matter is eliminated by introducing topics with problems which are designed to stimulate thinking and arouse interest in the material under consideration.

4. Attention is given to approximate computation. The reviewer believes this is the first attempt to present this important topic in a Junior High School series under the ninth year.

5. Standardized tests are provided. These are designed to include time for checking.

6. Provision is made for individual differences both in instruction and drill, and by starred problems for the stronger pupils. The material of the book seems to have been well chosen for holding the interest of pupils of these grades. J. M. Kinney.

Quantitative Analysis by Stephen Popoff, Ph.D., Assistant Professor and Head of Analytical Chemistry, State University of Iowa. Second edition. Cloth. Pages xix+559. 23x15 cm. P. Blakiston's Son & Co. Price $4.00.

This revision follows the same general plan that was adopted in the first edition, i. e. it is a combined laboratory manual and textbook. The four main parts consist of laboratory instructions, calculations, theory of analytical chemistry, and a discussion of three special topics; viz., electrometric titration, conductimetric methods, and iron and steel analysis.

The laboratory instructions are not mere directions for manipulation but give complete theory of the instruments and apparatus used. Five chapters are devoted to the discussion of the analytical balance and weighing. In the section on computation the two new chapters on errors and computation rules should save time for both instructors and students. The theoretical discussions in part three are written in a clear and easy style which stimulates the interest of the young student and increases his respect for the skill and precisions in experimentation, which has brought about the rapid development of chemistry in recent years. Chapter numbers are followed by a subscript a, b or c designating the degree of difficulty so that a beginning student may readily select essential material fitted to his ability, while the more advanced student is also provided for. The lists of references following many of the chapters provide for more extensive study than the size of the book will permit. The author and the publishers are to be congratulated for this excellent addition to the chemists library. G. W. W.

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